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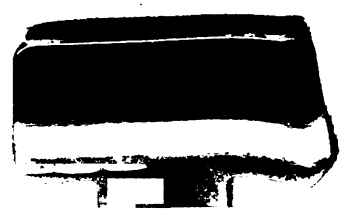

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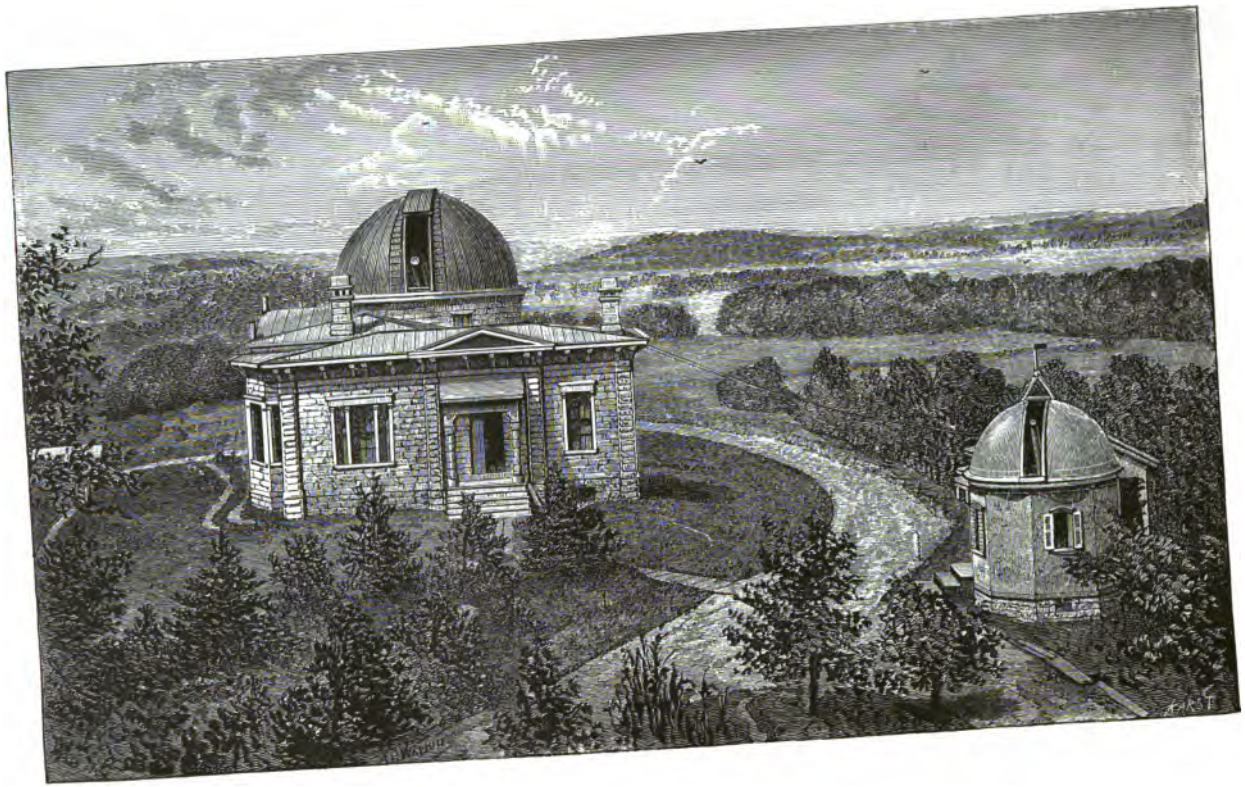

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# PUBLICATIONS

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## VOL. II.

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DEMOCRAT PRINTING COMPANY, STATE PRINTERS.
1884.

WASHBURN OBSERVATORY.

FOUNDED BY

## CADWALLADER C. WASHBURN,

BORN 1818; DIED 1882.

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| | |
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| GEORGE W. BROWN, (Student) | METEOROLOGICAL OBSERVER.‡ |
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*Absent in charge of the U. S. Solar Eclipse Expedition to the South Pacific Ocean March—July 1883, during which time Mr. GEORGE CARY COMSTOCK was in charge of the Observatory, with Mr. G. E. BROWN as assistant.

†From July 1, 1883, to August 1, 1884. ‡Since December 12, 1883.

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# WASHBURN OBSERVATORY.

## I. ADDITIONS TO THE BUILDINGS AND INSTRUMENTS.

At the date of the printing of Volume I. of the *Publications of the Washburn Observatory,* the buildings were practically completed, as shown in the frontispiece of the present volume.

Some slight changes have been made however, and the most important of these will be briefly mentioned. A few instruments and minor pieces of apparatus have also been bought.

### WEST ROOM (*Meridian-Circle.*)

The interior of this room has been completely remodeled in order to fit it to receive the REPSOLD Meridian Circle, mounted at the close of 1882. The room is only 22 feet 4 inches (E. and W.) by 20 (N. and S.) This is really too small, but by economizing our space it has been made satisfactory. The piers and the principal fittings for the Circle proper will be spoken of in the *Description of the Meridian Circle.* Here it may be said that the shutters have been changed so as to work fairly well; and especially that the ventilation of the room has been improved so as to insure an equality between the exterior and interior temperatures. How this has been effected is related in the *Description* above cited.

A double-shelter for the Meteorological Instruments has been placed at the north-east window. The two south windows have been painted with a thin coat of white paint. This allows light to pass and prevents the Sun's heat from affecting the Circle. A small stove has been mounted in the room permanently. It is lighted whenever the instrument begins to drip with dew, as is not uncommon in the spring and fall.

LARGE DOME.

This continues to be satisfactory in all respects, except that the upper shutter should be replaced by one of light steel.

EAST ROOM (*Clock-Room.*)

No changes have been made in the room itself. The pier on the north side of the room has been used for the HOWARD Mean Time Clock (No. 221), since 1882, July 7th. The THOMAS Clock has been moved into the Hall, near the switch-board. A oil-painting of Governor WASHBURN, and a life size crayon drawing of Professor WATSON have been placed in this room.

THE SOLAR AND STUDENTS' OBSERVATORIES.

The Solar observatory has been used solely as the quarters for an assistant after the conclusion of the experiments described in *V. J. S. der Ast. Gesell,* 1883, page 114. The Students' observatory has been lighted with gas since November 1882.

THE PIVOTS OF THE FAUTH TRANSIT INSTRUMENT.

The inequality of the pivots of the Fauth Transit has been investigated by Miss ALICE SANBORN, student in Astronomy. The results are as follows:

INDIVIDUAL VALUES OF P.

*First Series.*—Telescope Pointing South.—1882.

| *Date.* | *p.* | *Date.* | *p.* | *Date.* | *p* |
|---|---|---|---|---|---|
| | d | | d | | d |
| Oct. 25, | + 0.10 | Nov. 1, | — 0.30 | Nov. 8, | — 0.25 |
| Oct. 25, | — 0.30 | Nov. 1, | — 0.36 | Nov. 8, | — 0.34 |
| Oct. 25, | — 0.33 | Nov. 2, | — 0.40 | Nov. 8, | — 0.27 |
| Oct. 25, | — 0.56 | Nov. 2, | — 0.42 | Nov. 8, | — 0.19 |
| Oct. 31, | — 0.30 | Nov. 2, | — 0.12 | Nov. 9, | — 0.39 |
| Oct. 31, | — 0.37 | Nov. 3, | — 0.27 | Nov. 9, | — 0.56 |
| Oct. 31, | — 0.49 | Nov. 3, | — 0.31 | Nov. 9, | — 0.05 |
| Oct. 31, | — 0.56 | Nov. 3, | — 0.22 | Nov. 9, | — 0.38 |
| Oct. 31, | — 0.34 | Nov. 3, | — 0.20 | Nov. 10, | — 0.38 |
| Nov. 1, | — 0.31 | Nov. 6, | — 0.22 | Nov. 10, | — 0.25 |
| Nov. 1, | — 0.41 | Nov. 6, | — 0.11 | Nov. 10, | — 0.35 |
| Nov. 1, | — 0.33 | Nov. 6, | — 0.25 | Nov. 10, | — 0.30 |
| Nov. 1, | — 0.24 | Nov. 6, | — 0.10 | | |

Mean value of $p = -\overset{d}{0}.3008 \pm \overset{d}{0}.0133$.

Probable error of one determination, $\pm\ \overset{d}{0}.0820$

$p = -\overset{s}{0}.0322 \pm \overset{s}{0}.0014$.

*Second Series.* Telescope pointing North.—1882-3.

| *Date.* | $p_d$ | *Date.* | $p_d$ | *Date.* | $p_d$ |
|---|---|---|---|---|---|
| Nov. 13, | — 0.11 | Nov. 20, | — 0.20 | June 12, | — 0.16 |
| Nov. 13, | — 0.20 | Nov. 20, | — 0.31 | June 12, | — 0.34 |
| Nov. 14, | — 0.34 | Nov. 21, | — 0.15 | June 12, | — 0.34 |
| Nov. 14, | — 0.35 | Nov. 21, | — 0.17 | June 12, | — 0.18 |
| Nov. 14, | — 0.24 | Nov. 21, | — 0.27 | June 12, | — 0.35 |
| Nov. 14, | — 0.14 | Nov. 21, | — 0.07 | June 12, | — 0.35 |
| Nov. 20, | — 0.16 | Nov. 21, | — 0.19 | June 12, | — 0.28 |
| Nov. 20, | — 0.36 | Nov. 21, | — 0.21 | June 12, | — 0.37 |
| Nov. 20, | — 0.17 | | | | |

Mean value of $p = -0.2404^{d} \pm 0.0140^{d}$.

Probable error of one determination, $\pm 0.0701^{d}$.

$p = -0.0257^{s} \pm 0.0015^{s}$.

Combining the result from both series we find $p = -0.029^{s} \pm 0.001^{s}$.

The linear difference in the radii of the pivots is 0.000053 inch, the clamp pivot being the larger.

## THE SIDEREAL CLOCK.

The Sidereal Clock has had its correction determined once every three days (on the average) since it was mounted. A daily comparison is made between this clock and all the other time-pieces in the Observatory; and the Tower Clock is also daily compared with the standard mean-time clock, through the telephone. A complete record of the running of each time-piece is kept.

The barometer and a thermom eter screwed to the wooden back of the sidereal clock case (inside the case) have also been read daily since August 1881.

During the period August 1883 to January 1884 the readings of a maximum and a minimum thermometer which are fastened inside the wall of the (outer) clock closet surrounding the sidereal clock have also been taken, as well as the reading of the clock thermometer at about 11 p. m.

Supposing the mean of the maximum and minimum thermometers to indicate the mean daily temperature of the air in the clock closet, the following points have been established. The temperature inside the clock case proper follows the temperature of the clock closet closely, being perhaps an hour in retard. The daily range of the tempera-

ture inside the clock-case is about the same as the daily range of temperature in the clock closet. The reading of the clock-thermometer at 7 a. m. is very nearly the mean daily temperature. The mean of the readings of the clock-thermometer at 7 a. m. and 11 p. m. is also very near the mean daily temperature, and there is no special advantage in reading the clock-thermometer more than once daily, *viz.* at 7 a. m. The clock is mounted on the very substantial pier in the following manner. A solid iron hook for the support of the back is set firmly at the top of the pier with plaster of Paris. A wooden batten (ash) is placed horizontally on the front of the pier, and at the same height above the floor is another batten, at the back of the pier. These two are connected by two iron rods with screws cut on their ends and nuts playing on these. Thus the two battens are clamped tightly against the faces of the pier. The bottom of the clock-case is clamped against the front batten by two large screws. The principle of this mounting is that the whole weight of the clock is suspended from the iron hook and that the back of the clock case is kept in one position by the screws which clamp it against the bottom batten. In spite of all precautions, I have found that the back of the clock case will warp from time to time and that it changes its shape from winter to summer. This warping destroys the effect of the accurate adjustment of the beat-screws of the clock, and it tends also to destroy the accurate swinging of the pendulum in one plane. Unless the pendulum swings in one plane the rate cannot be constant.

I therefore think that for the best performance of this clock, it would be proper to fasten the wooden back of the clock case firmly against an iron back, and to bolt this iron back firmly to the pier. The iron back of the HOWARD mean time clock is an excellent feature of its mounting.

I have not been able to allow the sidereal clock to run without stopping for the period of 1881 April to 1883 December, as I had hoped, but I have had to stop it on several occasions, in order to adjust the swinging of the pendulum to one plane.

The periods which are available for discussion of the running of this clock are:

1881. August — December.
1882. January — December.
1883. January — June.
1883. June — December.

If $R_o$ be the rate of the clock at barometer = 30 inches and thermometer = 40°, and R be the rate of the clock at a given barometer (B) and the temperature (t), the formula which best represents the running of the clock is

$$R = R_o + 0^s.30\ (B - 30) - 0^s.034\ (t - 40^o).$$

It is obvious that the temperature coefficient is enormously too large, and I shall alter the quantity of mercury in the jar, until a better compensation is secured, beginning these changes with the year 1884. I have compared the rate computed from the above formula with the observed rate for 100 different cases, from January 1882, to December 1883, and I find that the sum of 100 residuals taken without regard to sign is $14^s.28$ or the average residual is $0^s.14$.

On 1884 January 12, I took out 54.50 grams of mercury, and placed two brass weights centrally on top of the pendulum bob.

On January 19th, the rate of the clock at barometer 30 inches and $t = 65.5^o$ was $+0^s.686$, and at barometer 30 inches and $t = 36.8$ it was $+0^s.402$. That is the formula given above was changed to $R = R_o + 0^s.30\ (B - 30) + 0^s.010\ (t - 40^o.)$

On January 21st, I replaced 13.8 grams of mercury, and in this condition, the clock will be allowed to run during 1884.

It must not be forgotten that the two circular pieces of brass which have been added are now to be considered as an integral part of the pendulum.

It should be mentioned that the maker of the clock has added to the pendulum bob (at the bottom) a small glass mirror. If a beam of sunlight be thrown upon this mirror a spot of light is reflected by it upon the west wall of the clock-room. Here I have placed a plumb-line, along which the spot travels, as the pendulum swings. This observation is made once or twice per month. The arc through which

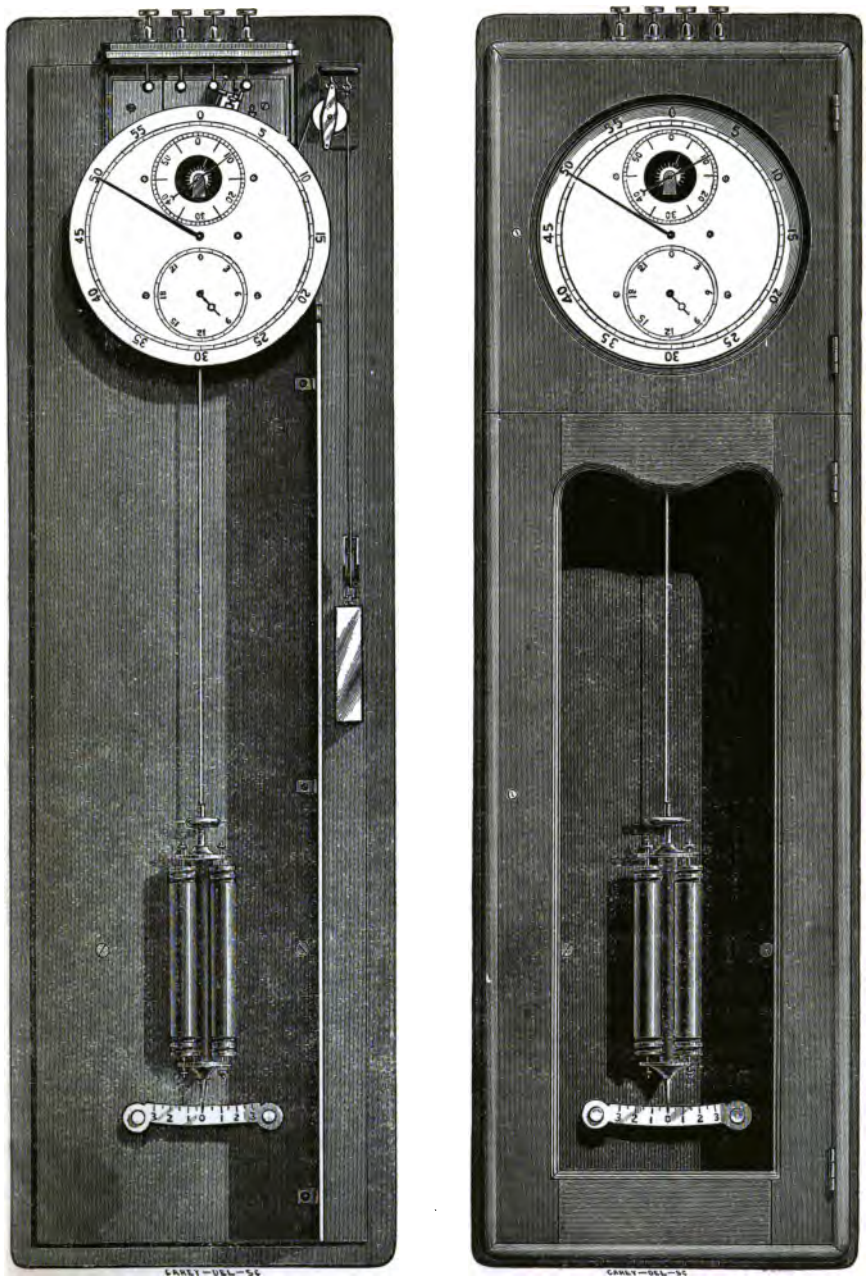
the pendulum swings is observed daily. It appears to decrease from 1°29′ to 1°25′ for a fall of temperature of 10°; and it also appears to decrease as the driving weight falls. I have increased the driving weight slightly, and it is possible that further experiments may determine that the clock should be wound daily.

### THE HOWARD CLOCK.

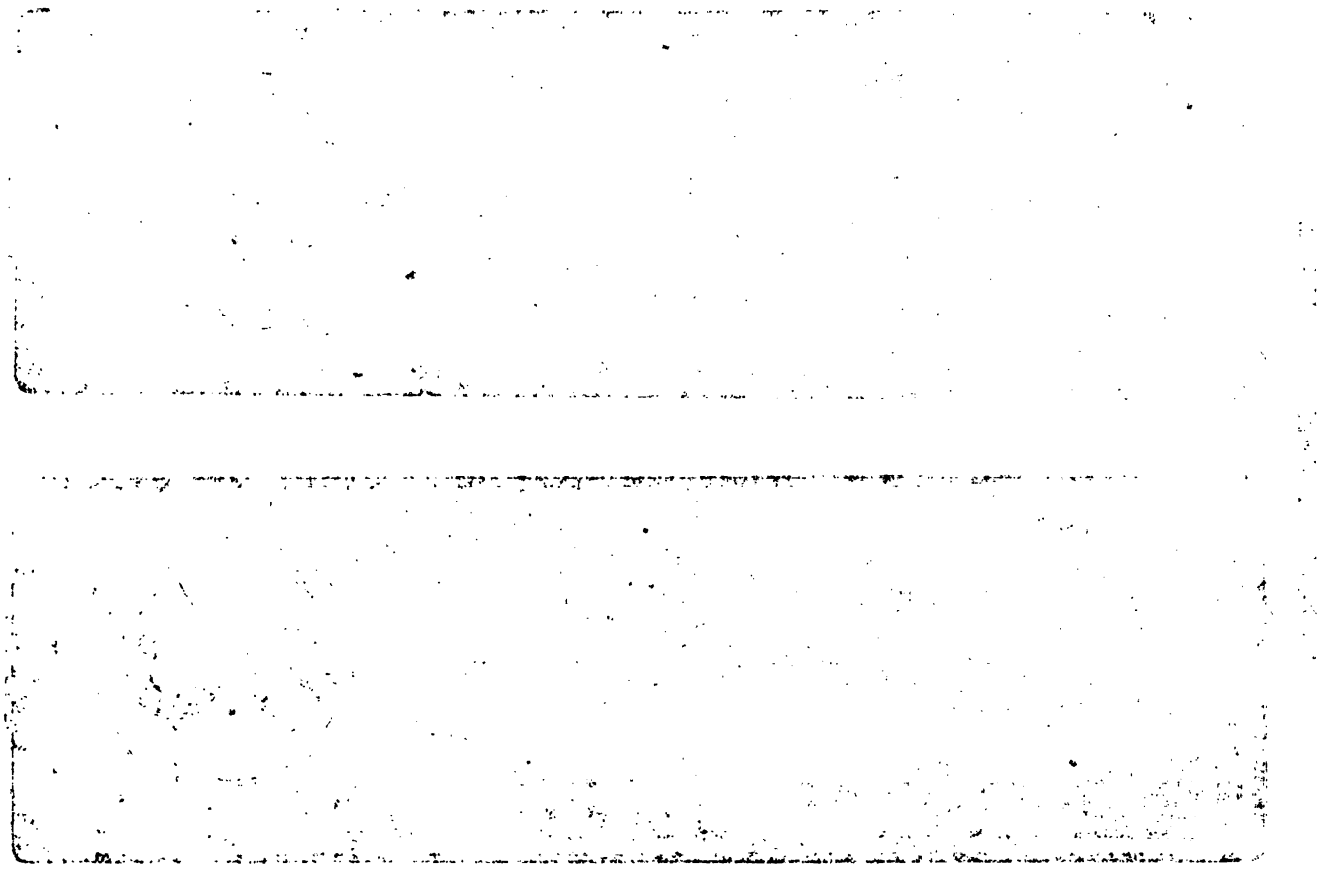
This clock is regulated to mean-time. Up to November 23 1883, its face showed Chicago mean-time. (Chicago $7^m$ $11^s$. 11 east of Madison.) After that date it showed "Central time," *i. e.* the local time of the meridian 90° west from Greenwich. (Central time is $2^m$ $22^s$. 11 slower than Madison time.) It is used as the standard mean-time clock, and especially to send a time-signal at 10 a. m. daily (except Sunday), to railways in Wisconsin, and to send signals every $2^s$ during the day-time to various places in the city of Madison.

The *escapement* is GRAHAM'S. The *pendulum* is a steel rod which carries four steel jars in a cluster, each jar being filled with mercury. The seconds-arbor has a steel scape wheel of thirty teeth (one being cut away). This wheel touches a spring every $2^s$ and sends a signal through a relay. The 58th second is omitted in every minute. A wheel on the 5-minute arbor has a notch $10^s$ long cut into its rim. Into this notch a detent falls once in 5 minutes, and the signals are interrupted every 5 minutes from $50^s$ to $60.^s$ The clock thus sends break-circuit signals (to its own "back-contact" relay at the switch-board) every $2^s$ with the exception of the 58th second in *every* minute and the 52d, 54th, 56th and 58th, in every 5th minute. From the relay either *break* or *make* signals can be sent. On the pendulum rod just above the bob, is a screw thread, on which a little nut can be moved up and down about 3 inches of the length of the rod. This nut is made in the shape of a pilot-wheel with 8 spokes, one of which has been painted black. One turn of the nut is $0^s.18$ per day in the rate, and one-eighth of a turn is $0^s.001$ per hour. This clock is compared twice daily with the sidereal clock, at 8 a. m. and about 11 p. m.

The nut is so placed as to bring the correction of the clock



THE HOWARD MEAN TIME CLOCK.



to as nearly zero as possible at 10 a. m. of the succeeding day. The average error of our railway time signals at 10 a. m., was:

For September, 1883, 0.$^s$08
For October, 1883, 0.07
For November, 1883, 0.11
For December, 1883, 0.06

The whole clock is mounted on an iron back, which is firmly screwed by 4 bolts (set into lead) to the stone pier.

The constant changes which are made in the rate of the clock have prevented me from forming any accurate idea of its performance. For its special purpose I regard its arrangements as well nigh perfect. Clocks of this maker should be always used so as to *open* a closed circuit, not to *close* an open one, as the adjustment of the 2$^s$ signal apparatus can be made much lighter.

### THE CONTROLLED CLOCKS.

The observatory controls seven clocks in the city of Madison. The single wire (No. 2) goes from the ground at the observatory to the tracks of the Chicago, Milwaukee & St. Paul Railway, and along these to the city, passing through clocks at the offices of S. L. SHELDON, the Western Union Telegraph Co., the State Bank, the Wisconsin State Journal, the first National Bank, the Supreme Court of Wisconsin, and of the Park Hotel. Here it goes to ground. Clocks along this line have their hands set hourly from the observatory. (DUDLEY system).

A special line is also run to the office of the President of the University, and a clock is set daily in this room. This clock automatically rings an electric bell in each class room at each hour, and ten minutes before each hour.

### THE LIBRARY.

The Library has received a gift of money from Hon. CYRUS WOODMAN of Cambridge, for the purchase of new books. It is now a very excellent working library of astronomy of about 1000 volumes and 600 pamphlets. In particular, its collections of recent star catalogues is very complete, and what is better, each catalogue has been corrected for every

known error up to now. The Washburn Observatory holds itself ready to correct the catalogues of other observatories on terms which are detailed in *Science* for 1883 August 24. Mr. WOODMAN has also given a permanent fund, half of the income of which is to be applied to the uses of the library, the other half going to increase the principal. The library is to be called the WOODMAN ASTRONOMICAL LIBRARY OF THE WASHBURN OBSERVATORY.

I desire to renew my thanks to the many scientific societies, observatories and astronomers who have generously presented the library with their publications; and to the Smithsonian Institution which forwards these to us free of expense.

### THE SIX-INCH CLARK EQUATORIAL.

The six-inch equatorial made by ALVAN CLARK & SONS in 1870, for Mr. S. W. BURNHAM, and temporarily mounted in the dome of the Students' Observatory in 1881, was bought by the Regents of the University in January, 1882, for $1200.

It has an aperture of six English inches, and the distance from the center of the objective to the webs of the micrometer is 93.75 inches. It is driven by an excellent clock.

There are four negative eyepieces, with which Mr. BURNHAM discovered some 400 of his double stars. They are:

| | | | | | |
|---|---|---|---|---|---|
| L | field | = 30′; | power | = 57 | Made by CLARK. |
| M | | = 15′; | | = 133 | |
| N | | = 7.5; | | = 250 | |
| O | | = ?; | | = 460 | |

Also a solar eyepiece, and a diagonal tube by CLARK. A poor micrometer by BROWNING has four eyepieces, w, x, y, z, of powers 125, 176, 300, 380. I have had an adapter made, so that the six-inch telescope will now carry any of the eyepieces of the large equatorial—even its micrometer.

### AURORA-SPECTROSCOPE.

The Trustees of the BACHE-fund of the National Academy of Sciences (Professor J. D. DANA, Dr. WOLCOTT GIBBS, Professor J. E. HILGARD) granted $300 from the income of the fund for the purpose of constructing a spectroscope especially for the purpose of observing the spectrum of the Aurora and

of the Zodiacal Light. This spectroscope is now making, from designs by Dr. C. S. HASTINGS.

The aperture of the telescope and collimator are 2.67 inches (triple objectives by STEINHEIL), their focal length is 13.4 inches. The eyepiece magnifies 17 diameters. The prism is of bisulphide of carbon and the apparatus gives a spectrum of 3° from A to H.

It is hoped to receive this instrument (which is the property of the National Academy of Sciences) during 1884, and to begin observations at once.

### MINOR INSTRUMENTS AND APPARATUS.

For the use of students there have been bought

*A* SPENCER & BROWNING *Sextant,*

*A mean-time chronometer* TOBIAS, No. 4804.

*An Astral lantern* (BAILEY'S),

*A sun-dial.*

A *spherometer-caliper,* made by FAUTH & Co., on the plans of Professor HARKNESS, U. S. Navy, has been used in connection with the pivots of the REPSOLD Circle as detailed in the *Description of the Meridian Circle.*

A STEINHEIL wedge ("moderations-glas") has been fitted for solar observations.

### METEOROLOGICAL INSTRUMENTS.

The instruments, etc., of the Signal Station of the U. S. Weather Bureau at Madison (abandoned) were turned over to the Observatory, and since August 1883, tri-daily observations (7 a. m., 2 p. m., 9 p. m.) are made according to the regular programme of the Signal Service for its volunteer observers. These are printed in what follows.

## II. DESCRIPTION OF THE REPSOLD MERIDIAN CIRCLE.

The Washburn Observatory has lately come into possession of a Meridian Circle by the REPSOLDS of Hamburg. In the course of setting this instrument in place, I have had occasion to examine certain parts of it thoroughly; other parts, as the division of the circle, I hope to examine subsequently in the same way. It has appeared to me that the results of this examination would be of especial interest to Astronomers in America, to whom the work of the REPSOLDS is not so familiar as it is to Europeans. In what follows, I have taken the liberty of expressing my own opinion freely, but not without reflection, as to the merits or demerits of our circle, as they appear to me. It is only in this way that my remarks can be of any value. In a few points it appears to me that improvements might be made; essentially I believe that the instrument is all but perfect. It also seems to me that these minor points should be explicitly mentioned, since they are all easy of correction by the makers.

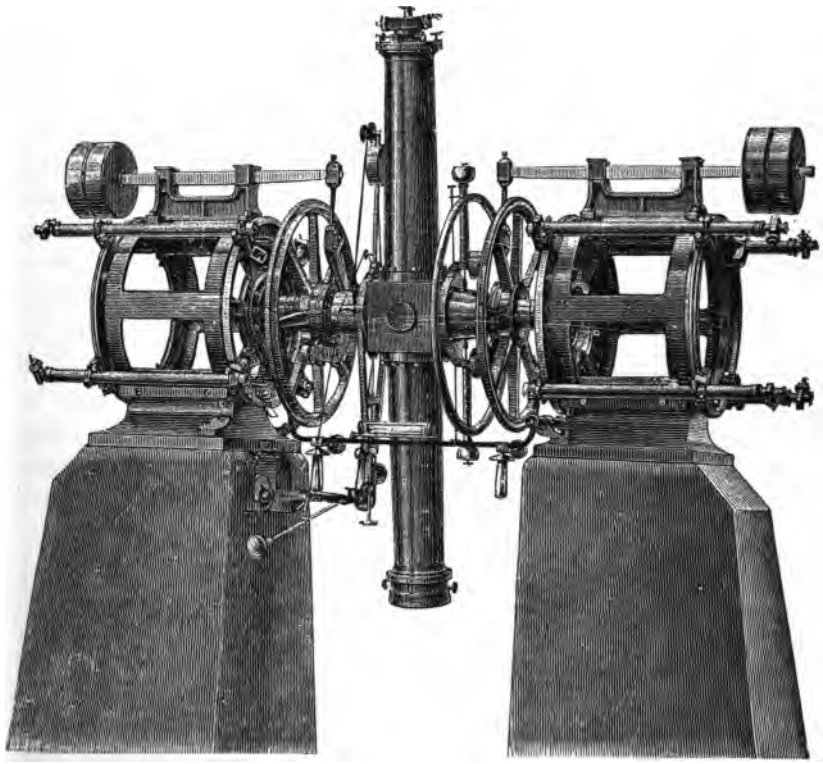
### COST OF THE MERIDIAN CIRCLE.

The bill for the circle was as follows:

| | | | | |
|---|---|---|---|---|
| Meridian circle (proper) | 15500 | | Marks | |
| Spare level tube (extra) | 60 | | " | |
| Diagonal eyepiece (extra) | 65 | | " | |
| Observing chair | 400 | | " | |
| Boxes and packing | 385 | | " | |
| Consul's fees (Hamburg) | 10 | 70 | " | |
| Freight to New York | 124 | | " | |
| Insurance to New York | 62 | | " | |
| Total cost in New York | 16,606 | 70 | " | $4,151 68 |
| The bill of the New York Agents of REPSOLDS was | | | | 122 33 |
| This includes express charges, insurance and custom house fees. The total cost of the circle delivered in the Observatory was therefore | | | | $4,274 01 |

The instrument is mounted in a room which had been prepared by Professor WATSON for the reception of a six inch transit. Extensive changes were made in this room to prepare it for the circle, and the cost of these was somewhere in the neighborhood of $600.

The instrument arrived in perfect order, except a few



slight scratches on the divided circle, and not a thing was broken. The spider lines in the reticles were all intact.

The boxes for the circles, the telescope and axis and the collimators were covered with tin, then with straw and finally sewed in bagging. I may mention that, on my application, the Honorable Secretary of the Treasury issued special directions to the officials in the New York Custom House, to handle the cases with care. I believe this precaution was worth taking.

### THE WEST ROOM (*Meridian Circle*).

The west room is 22 feet 4 inches (east and west) by 20 feet (north and south), and 13 feet 9 inches high to the flat ceiling. A slit 25 inches wide is closed by two counterpoised shutters on the sloping roof (the ridge line running east and west), and by four vertical shutters, two north and two south.

The ridge-line is 140 inches higher than the flat ceiling; the eaves being 66 inches higher. The space above the ceiling serves as an air space, and the sides of the slit are not ceiled up, as is usual, but they are covered with wire netting on both sides of the slit, so as to allow a free circulation of air. This arrangement is, I believe, first carried out at the Washburn Observatory. Forty-four ventilators in the walls and cornice allow of changing the air.

Prof. WATSON had mounted in this room a 6-inch meridian transit instrument, made by PISTOR & MARTINS in 1856, for the United States Coast Survey. This instrument was his own private property, and it was replaced by the meridian circle ordered from the REPSOLDS, by Governor WASHBURN, early in 1881.

### GENERAL DESCRIPTION OF THE MERIDIAN CIRCLE.

The general appearance of the instrument can be seen in the cut herewith.

A photograph of this instrument can be had from the Messrs. REPSOLDS by any one who wishes it. By studying the photograph, or in default of this, the accompanying wood-cut, a better idea of the general construction can be had than by any brief description.

It may be said, however, that all the large iron surfaces are painted an olive green, with the edges bronzed, so as to give a good effect, and so as to protect from rust. The iron or steel screws are all, without exception, nickel-plated, also to avoid rust; and the brass surfaces are lackered. The nickel-plating is a particularly good feature in climates like that of Madison, where for two or three months of the year the air is quite moist, and where instruments are liable to "sweat" badly. It really saves the inconvenience of a glass cover like those at Pulkova and Leyden.

A small point, but a good one, is that the caps for the objectives of the collimators and of the circle, are made of spun-brass, and are therefore light. In general, the only thing to do with the cap furnished by the maker of an instrument, is to throw it away. They are usually so heavy and awkward as to do more harm than good.

Most of the screw heads are fitted to be set up *either* by a screw driver or by a capstan bar. I may mention here that in the one case where it was most important that one should be able to use a screw driver (for two opposing screws which make the transit threads vertical) on account of the small room available between the end of the tube and the micrometer, the screws were made capstan-headed *only*. I have changed these.

As a matter of history, it may be interesting to say that the first capstan-headed screws were made for the CARY circle at Moscow, which is figured in PEARSON'S Practical Astronomy.

### THE REVERSING CARRIAGE.

This is made of wood, with the moving parts in brass or iron. A strong pressure will spring it slightly, and I think it would have been better if the frame had been made of iron. The large screw is not equally well cut throughout its length, one thread being especially defective. The carriage is supported on two wheels on one side, and the third wheel on the other side can be raised or lowered, in order to get the arms perfectly horizontal. It runs on two tracks, one of which is grooved (for the two wheels) and the other is plane.

Five minutes is about the shortest time in which two persons can safely reverse the instrument.

In ordering a circle from the REPSOLDS it is important to have them specify the exact free space between the casings of the piers.

### THE OBSERVING CHAIR.

The style of this may be seen from the photographs of the Strassburg circle.

With the smaller circles the use of a diagonal eyepiece does away with the necessity for a chair in great measure. I have two sets of 3 steps, 24 inches high and narrow enough to go between the piers. These are needed to read the collimator levels with, and they replace an observing chair for all stars of high elevation. The chair may be found very convenient for the observation of stars in a zone, but for general purposes I consider it inferior to that arranged by Professor HARKNESS for the Naval Observatory Transit Circle.

### THE PIER-HEADS.

On the top of the piers two plates of iron are bolted, and on these, supported by three screws, rest the circular microscope bearers. The pier heads, as we may call the iron base plates, should have been planed on the bottom. My brick piers were far more nearly plane surfaces than the bottoms of these bases, when they were received. I had them planed, however, at the University machine shop, and they would then stay in the positions given to them by the adjusting screws, and not rock to and fro. The microscope bearers can be pushed east and west by two opposing screws, and they can be pushed north and south, also, by four such screws. Three screws at the bases of the microscope bearers are provided for the adjustment in level.

### HOLDERS FOR THE DECLINATION CLAMP AND SLOW MOTION.

In our circle they are screwed to the base plates of the microscope bearers by two iron hangers.

The iron pier heads are fastened to the brick piers by two iron plates which are held by nuts to two bolts set, one in each pier, solidly in the brick. I have used plaster of Paris

for setting these and for fastening the Ys of the collimators also. As the piers were thoroughly dry, I found it necessary to moisten the brick work before putting it in the plaster.

These bolts should be set as low as possible, as they cast a shadow on the mirror for illuminating the setting microscope and they should have been countersunk in their plates.

### THE YS FOR THE COLLIMATORS.

The Ys for the collimators should have had their bases planed. As a matter of fact the only difficulty I have had with the mounting of the whole circle arose from the fact that I attempted to mount the Ys without having previously planed these surfaces. The Ys are provided with all necessary adjustments in level and azimuth, and the whole collimator as mounted, is a great advance upon the REPSOLD collimator described in the *Astronomische Nachrichten* No. 1033.

### COLLIMATORS.

There are two collimators exactly alike. The objectives are by MERZ 2.63 inches (67 m. m) in aperture. The eyepieces sent with these magnified 48 diameters and the probable error of a single setting of one collimator on its opposite was 0″.2. I have replaced the original eyepieces by two made by KAHLER, of Washington, which magnify 65 diameters. The probable error of a single setting is now 0″.08 and the setting is done in half the time. Here as in many other cases, the saving of time goes with the increase of precision. I have marked the collimators X and Y. They should have been marked by the maker, as well as the microscopes, eyepieces, etc.

Also it was necessary to provide two caps to fit over the eyepieces, so that the light from the gas-flame should pass through oiled paper before entering the field of view.

The collimators are provided with four stops, 90° apart, which abut against a small lever adjustable in length. In this way it is easy to rotate the collimators about their optical axes through angles of 90° or 180°.

The pivots of the collimators are 3.88 inches in diameter, and are at the very ends of the tube, which is a good plan,

as the objective and the threads are respectively directly over the Ys in a vertical plane. The pivots are kept always free from dust by two covers on the Ys of the collimator levels. I have had plate glass hoods made for the two collimators. The distance between the bearing points of the pivots is about 24.6 inches. All the bearing surfaces of the Ys of both collimators and instrument are made of softer metal, so that these will wear and not the pivots themselves.

The bearings are not surfaces but lines. Two abutting-screws (moving north and south) keep each collimator in its place. Each collimator presses with a weight of about 4½ pounds on each Y. There is an adjustment to this.

The difference of the objective pivot and of the eyepiece pivot of each collimator was determined by levels taken in reversed positions.

The pivots of collimator X are of exactly the same size.

The objective-end pivot of collimator Y is smaller than the eye-end pivot by 0.″19 ± 0.″06.

The linear difference in diameters corresponding to 0.″19 is 0.000016 inches.

The observations upon which these results depend are given in the following paper by Miss ALICE SANBORN, one of my students.

"In the following investigation the collimators designated X and Y belong to the Repsold Meridian Circle of the Washburn Observatory. They are of brass, mounted upon brick piers, 59.06 inches from the floor, in cast iron Ys. The extreme length of each collimator is 25.4 ± inches and the length between the bearings 24.6 ± inches. The diameter of the pivots is 3.88 ± inches.

The levels used are numbered 1399 and 1396. The length of the former, between bearings, is 24.64 inches and of the latter, 24.61 inches. The angle of the Level Ys and the Ys in which the collimators rest were found upon examination to be equal, and each measured 90°.

The determinations of the inequality of pivots of the collimators X and Y are in *two* sets of sixteen determinations each. Eight determinations were obtained with Level No. 1396 and eight with Level No. 1399. During the first set

Collimator Y was on the North Pier and Collimator X on the South Pier. For the second set this order was reversed. Care was taken in all minor details of the operation to insure accurate results. The Ys of the levels, and the pivots and Ys of the collimators were thoroughly wiped before each day's determinations. In the second set of measures special precaution was taken to place the collimators in the Ys with the micrometer threads vertical for the first determination and horizontal for the second, in order that inequalities of both the horizontal and vertical diameters should be eliminated. The levels used were parallel to their axes.

One division of Level 1396 is equal to 1."29. One division of Level 1399 is equal to 1."45.

For the notation used in the following tables, and formula to obtain the inequality of pivots, see CHAUVENET'S *Spherical and Practical Astronomy*, Vol. II, §137."

See the tables which follow.

To sum up, the results of the two sets of determinations are:

| | | | |
|---|---|---|---|
| 1st set | Col. X | Level 1396 | $p = -0''.054 \pm 0''.042$ |
| | Col. X | Level 1399 | $p = +0''.106 \pm 0''.046$ |
| 2d set | Col. X | Level 1398 | $p = +0''.095 \pm 0''.062$ |
| | Col. X | Level 1399 | $p = +0''.064 \pm 0''.078$ |
| | | Mean value, | $p = +0''.053 \pm 0.0294$ |

That is, these pivots are equal.

| | | | |
|---|---|---|---|
| 1st set | Col. Y | Level 1396 | $p = +0''.337 \pm 0''.051$ |
| | Col. Y | Level 1399 | $p = +0''.130 \pm 0''.048$ |
| 2d set | Col. Y | Level 1396 | $p = +0''.160 \pm 0''.004$ |
| | Col. Y | Level 1399 | $p = +0''.127 \pm 0''.056$ |
| | | Mean value, | $p = +0''.191 \pm 0.0275$ |

That is, the object-end pivot is smaller than the eye-end pivot by $0''.19$.

The linear difference of the radii of the pivots is deduced from the formula given by CHAUVENET, Vol. II, § 140. The mean of the values for inequality thus obtained, are: for collimator X+0.00000445 inches and for collimator Y+0.0000161 inches, which shows the perfection of the workmanship.

The north collimator reticle is north of the circle 8.2 feet, and the reduction is $\Delta\varphi = -0''.11$ The south collimator has a reduction of $\Delta\varphi = +0''.11$.

COLLIMATOR X — FIRST SERIES.

| Date. | Level No. | Objective. | +Means N. end high. | | +Means obj. pivot small. | | Level Constant. b=B+p. b′=B′−p. | |
|---|---|---|---|---|---|---|---|---|
| | | | Objective N. B. | Objective S. B′. | $p^d = \frac{1}{2}(B'-B)$. | $p''$ | $b^d$ | $b''$ |
| 1883. | | | | | | | | |
| January 19... | 1396 | N. | −0.250 | ..... | | | b =−0.18 | −0.23 |
| | | S. | ..... | +0.050 | +0.07 | +0.09 | b′=−0.02 | −0.03 |
| | | S. | ..... | +0.700 | | | b =+0.49 | +0.63 |
| | | N. | +0.425 | ..... | +0.07 | +0.09 | b′=+0.63 | +0.81 |
| | | N. | +0.050 | ..... | | | b =−0.03 | −0.04 |
| | | S. | ..... | −0.275 | −0.08 | −0.10 | b′=−0.19 | −0.25 |
| | | S. | ..... | −0.900 | | | b =−0.16 | −0.21 |
| | | N. | +0.075 | ..... | −0.24 | −0.31 | b′=−0.66 | −0.85 |
| January 29... | | N. | +4.900 | ..... | | | [b =+4.76] | [+6.14] |
| | | S. | ..... | [+4.350] | [−0.14] | [−0.18] | [b′=+4.49] | [+5.79] |
| | | S. | ..... | +3.975 | | | b =+3.96 | +5.11 |
| | | N. | +3.950 | ..... | +0.01 | +0.01 | b′=+3.96 | +5.11 |
| | | N. | +3.975 | ..... | | | b =+4.05 | +5.22 |
| | | S. | ..... | +4.300 | +0.08 | +0.10 | b′=+4.22 | +5.44 |
| | | S. | ..... | +3.950 | | | b =+4.25 | +5.48 |
| | | N. | +4.350 | ..... | −0.10 | −0.13 | b′=+4.05 | +5.22 |

$0^d.401$ $\quad -0''.054 \pm 0.042$

Probable error of single determination $=0''.120$.

COLLIMATOR X.— FIRST SERIES.

| Date. | Level No. | Objective. | +Means N. end high. | | +Means obj. pivot small. | | Level constant. b=B+p b′=B′−p | |
|---|---|---|---|---|---|---|---|---|
| | | | Objective N. B. | Objective S. B′. | $p^{d}=\frac{1}{2}(B'-B)$ | $p''$ | $b^{d}$ | $b''$ |
| 1883. | | | | | | | | |
| January 11... | 1399. | N. | +2.075 | ..... | | | b=+2.07 | +3.00 |
| | | S. | ..... | +2.075 | 0.00 | 0.00 | b′=+2.07 | +3.00 |
| | | S. | ..... | +1.450 | | | b=+1.16 | +1.68 |
| | | N. | +1.075 | ..... | +0.09 | +0.13 | b′=+1.36 | +1.97 |
| | | N. | +1.275 | ..... | | | b=+1.15 | +1.66 |
| | | S. | ... ..... | +0.800 | −0.12 | −0.17 | b′=+0.92 | +1.33 |
| January 15... | | S. | ..... | +2.475 | | | b=+1.53 | +2.22 |
| | | N. | +1.225 | .. ..... | +0.31 | +0.45 | b′=+2.16 | +3.11 |
| January 16... | | N. | +0.425 | ... ..... | | | b=+0.56 | +0.81 |
| | | S. | ..... | +0.975 | +0.14 | +0.20 | b′=+0.83 | +1.20 |
| | | S. | ..... | +0.450 | | | b=+0.24 | +0.35 |
| | | N. | +0.175 | ..... | +0.07 | +0.10 | b′=+0.38 | +0.55 |
| | | N. | +0.050 | ..... | | | b=+0.11 | +0.16 |
| | | S. | ..... ..... | +0.300 | +0.06 | +0.08 | b′=+0.24 | +0.35 |
| January 29... | | S. | ..... | +3.950 | | | b=+3.84 | +5.57 |
| | | N. | +3.800 | ..... | +0.04 | +0.06 | b′=+3.91 | +5.67 |

$+0.074^{d}$ $+0''.106 \pm 0''.046$.

Probable error of single determination, $\pm 0''.129$

COLLIMATOR X—SECOND SERIES.

| Date. | Level. No. | Objective. | +Means N. end high. | | +Means obj. pivot small. | | Level Constant. b=B+p b′=B′−p | |
|---|---|---|---|---|---|---|---|---|
| | | | Objective N. B. | Objective S. B′. | $p^d=\frac{1}{2}(B'-B)$ | p″ | $b^d$ | b″ |
| 1883. | 1399. | | | | | | | |
| February 28.. | | N. | −2.875 | ..... | | | b =−2.69 | −3.90 |
| | | S. | ..... | −2.150 | +0.18 | +0.26 | b′=−2.33 | −3.38 |
| | | S. | ..... | −2.350 | | | b =−2.09 | −3.07 |
| | | N. | −2.000 | ..... | −0.09 | −0.13 | b′=−2.26 | −3.28 |
| March 5..... | | N. | −0.525 | ..... | | | b =−0.65 | −0.94 |
| | | S. | ..... | −1.050 | −0.13 | −0.19 | b′=−0.92 | −1.33 |
| | | S. | ..... | −0.900 | | | b =−1.09 | −1.58 |
| | | N. | −1.150 | ..... | +0.06 | +0.08 | b′=−0.96 | −1.39 |
| March 6..... | | N. | −0.000 | ..... | | | b =−0.02 | −0.03 |
| | | S. | ..... | −0.100 | −0.02 | −0.03 | b′=−0.08 | −0.12 |
| | | S. | ..... | +0.025 | | | b =−1.53 | −2.22 |
| | | N. | −2.050 | ..... | +0.52 | +0.75 | b′=−0.49 | −0.71 |
| March 7..... | | N. | −4.600 | ..... | | | b =−4.48 | −6.50 |
| | | S. | ..... | −4.125 | +0.12 | +0.17 | b′=−4.24 | −6.15 |
| | | S. | ..... | −4.450 | | | b =−3.50 | −5.07 |
| | | N. | −3.225 | ..... | −0.28 | −0.40 | b′=−4.27 | −6.19 |

$+0.^d045$. +0.″064±0″.078.

Probable error of single determination, 0.″220.

COLLIMATOR X—SECOND SERIES.

| Date. | Level No. | Objective. | + Means N. end high. | | + Means obj., pivot small. | | Level Constant. b=B+p b′=B′−p | |
|---|---|---|---|---|---|---|---|---|
| | | | Objective N. B | Objective S. B′ | $p^d=\frac{1}{2}(B'-B)$ | p″ | $b^d$ | b″ |
| 1883. | | | | | | | | |
| February 28.. | 1396 | N. | −3.075 | ..... | | | b =−3.19 | −4.11 |
| | | S. | ..... ..... | −3.550 | −0.12 | −0.15 | b′=−3.43 | −4.42 |
| | | S. | ..... | −2.825 | | | b =−3.59 | −4.63 |
| | | N. | −3.851 | ..... | +0.26 | +0.34 | b′=−3.08 | −3.97 |
| March 5.. ... | | N. | −0.375 | ..... | | | b =−0.38 | −0.49 |
| | | S. | ..... | −0.400 | −0.01 | −0.01 | b′=−0.39 | −0.50 |
| | | S. | ..... | −0.350 | | | b =−0.99 | −1.28 |
| | | N. | −1.200 | ..... | +0.21 | +0.27 | b′=−0.56 | −0.72 |
| March 6..... | | N. | −0.825 | ..... ..... | | | b =−0.81 | −1.04 |
| | | S. | ..... | −0.775 | +0.01 | +0.01 | b′=−0.78 | −1.01 |
| | | S. | ..... | −0.550 | | | b =−0.47 | −0.61 |
| | | N. | −0.450 | ..... | −0.02 | −0.03 | b′=−0.53 | −0.68 |
| March 7..... | | N. | −4.450 | ..... | | | b =−4.57 | −5.89 |
| | | S. | ..... | −4.950 | −0.12 | −0.15 | b′=−4.83 | −6.23 |
| | | S. | ..... | −3.850 | | | b =−4.98 | −6.42 |
| | | N. | −5.350 | ..... | +0.37 | +0.48 | b′=−4.22 | −5.44 |
| | | | | | $+0^d.072$ | +0.″095 ± 0.″062 | | |

Probable error of single determination, 0.″155.

COLLIMATOR Y — FIRST SERIES.

| Date. | Level No. | Objective. | + Means N. end high. | | + Means obj., pivot small. | | Level Constant. b=B+p b′=B′−p | |
|---|---|---|---|---|---|---|---|---|
| | | | Objective N. B. | Objective S. B′. | $\overset{d}{p}=\frac{1}{4}(B'-B)$ | p″ | b | b″ |
| 1883. | | | | | | | | |
| January 17... | 1396 | N. | −0.750 | ..... | | | b = −0.45 | −0.58 |
| | | S. | ..... | +0.450 | +0.30 | +0.39 | b′ = +0.15 | +0.19 |
| | | S. | ..... | +0.500 | | | b = −1.12 | −1.44 |
| | | N. | −0.800 | ..... | +0.32 | +0.41 | b′ = +0.18 | +0.23 |
| | | N. | −1.225 | ..... | | | b = −0.79 | −1.02 |
| | | S. | ..... | +0.500 | +0.43 | +0.55 | b′ = +0.07 | +0.09 |
| | | S. | ..... | +0.375 | | | b = −0.73 | −0.94 |
| | | N. | −1.100 | ..... | +0.37 | +0.48 | b′ = +0.00 | 0.00 |
| January 18... | | N. | −1.350 | ..... | | | b = −0.99 | −1.28 |
| | | S. | ..... | +0.100 | +0.36 | +0.46 | b′ = −0.26 | −0.34 |
| | | S. | ..... | −0.525 | | | b = −0.67 | −0.86 |
| | | N. | −0.725 | ..... | +0.05 | +0.06 | b′ = −0.57 | −0.74 |
| | | N. | −0.600 | ..... | | | b = −0.64 | −0.83 |
| | | S. | ..... | −0.750 | −0.04 | −0.05 | b′ = −0.71 | −0.92 |
| | | S. | ..... | +0.275 | | | b = −0.66 | −0.85 |
| | | N. | −0.975 | ..... | +0.31 | +0.40 | b′ = −0.03 | −0.04 |

Probable error of single determination. 0″.144 $\overset{d}{+}0.262$ +0″337 ± 0″051

COLLIMATOR Y — FIRST SERIES.

| Date. | Level No. | Objective. | + Means N. end high. | | + Means obj. pivot small. | | Level Constant. b=B+p. b′=B′−p, | |
|---|---|---|---|---|---|---|---|---|
| | | | Objective N. B. | Objective S. B′. | $p^d=\frac{1}{2}(B'-B)$ | p″ | $b^d$. | b″. |
| 1883. | | | | | | | | |
| January 8.... | 1399 | N. | −2.025 | ..... | | | b =−2.02 | −2.93 |
| | | S. | ..... | −1.975 | +0.01 | +0.01 | b′ =−1.99 | −2.88 |
| | | S. | ..... | −1.925 | | | b =−2.10 | −3.04 |
| | | N. | −2.175 | ..... | +0.08 | +0.11 | b′ =−2.01 | −2.91 |
| January 9.... | | N. | −3.025 | ..... | | | b =−2.84 | −4.12 |
| | | S. | ..... | −2.300 | +0.18 | +0.26 | b′ =−2.48 | −3.59 |
| | | S. | ..... | −2.875 | | | b =−2.98 | −4.32 |
| | | N. | −3.025 | ..... | +0.04 | +0.06 | b′=−2.91 | −4.22 |
| January 10... | | N. | −3.025 | ..... | | | b =−3.05 | −4.42 |
| | | S. | ..... | −1.625 | +0.36 | +0.52 | b′ =−1.98 | −2.87 |
| | | S. | ..... | 2.950 | | | b =−2.63 | −3.81 |
| | | N. | −2.525 | ..... | −0.11 | −0.16 | b′ =−2.84 | −4.12 |
| | | N. | −3.000 | ..... | | | b =−2.84 | −4.12 |
| | | S. | ..... | 2.350 | +0.16 | +0.23 | b′ =−2.19 | −3.17 |
| January 15... | | S. | ..... | 2.500 | | | b =−2.69 | −3.90 |
| | | N. | −2.750 | ..... | +0.06 | +0.08 | b′ =−2.56 | −3.71 |
| | | | | | $+0^d.097$ | +0.″139±0.″048 | | |

Probable error of single determination =0″.136.

COLLIMATOR Y.—SECOND SERIES.

| Date. | Level No. | Objective. | +Means N. end high. | | +Means obj. pivot small. | | Level Constant. b=B+p b′=B′−p | |
|---|---|---|---|---|---|---|---|---|
| | | | Objective N. B | Objective S. B′ | $p^d=\frac{1}{2}(B'-B)$ | $p''$ | $b^d$ | $b''$ |
| 1883. | | | | | | | | |
| March 1..... | 1399 | N. | +3.775 | ..... | | | b = +3.84 | +5.57 |
| | | S. | ..... | +4.050 | +0.07 | +0.10 | b′ = +3.98 | +5.77 |
| | | S. | ..... | +4.275 | | | b = +3.54 | +5.13 |
| | | N. | +3.300 | ..... | +0.24 | +0.35 | b′ = +4.03 | +5.84 |
| March 5..... | | N. | +1.375 | ..... | | | b = +1.32 | +1.91 |
| | | S. | ..... | +1.175 | −0.05 | −0.07 | b′ = +1.22 | +1.77 |
| | | S. | ..... | +1.525 | | | b = +0.94 | +1.36 |
| | | N. | +0.750 | ..... | +0.19 | +0.27 | b′ = +1.33 | +1.93 |
| March 6..... | | N. | +1.250 | ..... | | | b = +1.15 | +1.67 |
| | | S. | ..... | +0.850 | −0.10 | −0.14 | b′ = +0.95 | +1.38 |
| | | S. | ..... | +0.225 | | | b = +0.48 | +0.70 |
| | | N. | +0.575 | ..... | −0.09 | −0.13 | b′ = +0.31 | +0.45 |
| March 7.. ... | | N. | −0.725 | ..... | | | b = −0.62 | −0.90 |
| | | S. | ..... | −0.325 | +0.10 | +0.14 | b′ = −0.42 | −0.61 |
| | | S. | ..... | 0.000 | | | b = −1.05 | −1.52 |
| | | N. | −1.400 | ..... | +0.35 | +0.50 | b′ = −0.35 | −0.51 |
| | | | | | $+0^d.089$ | +0.″127 ± 0.″056 | | |

Probable error of single determination, 0.″158.

COLLIMATOR Y—SECOND SERIES.

| Date. | Level No. | Objective. | +Means N. end high. | | +Means obj. pivot small. | | Level Constant. b′=B+p b′=B′−p | |
|---|---|---|---|---|---|---|---|---|
| | | | Objective N. B. | Objective S. B′. | $p^{d}=\frac{1}{2}(B'-B)$ | p″ | $b^{d}$ | b″ |
| 1883. | | | | | | | | |
| March 1..... | 1396. | N. | +3.675 | ..... | | | b=+4.25 | +4.48 |
| | | S. | ..... | +6.000 | +0.58 | +0.75 | b′=+5.42 | +6.99 |
| | | S. | ..... | +5.675 | | | b=+4.87 | +6.28 |
| | | N. | +4.600 | ..... | +0.27 | +0.35 | b′=+5.40 | +6.97 |
| March 5..... | | N. | +1.075 | ..... | | | b=+1.08 | +1.39 |
| | | S. | ..... | +1.100 | +0.01 | +0.01 | b′=+1.09 | +1.41 |
| | | S. | ..... | +1.425 | | | b=+1.11 | +1.43 |
| | | N. | +1.000 | ..... | +0.11 | +0.14 | b′=+1.31 | +1.69 |
| March 6..... | | N. | +1.000 | ..... | | | b=+1.01 | +1.30 |
| | | S. | ..... | +1.025 | +0.01 | +0.01 | b′=+1.01 | +1.30 |
| | | S. | ..... | +0.700 | | | b=+0.70 | +0.90 |
| | | N. | +0 700 | ..... | +0.00 | +0.00 | b′=+0.70 | +0.90 |
| March 7..... | | N. | −1.425 | ..... | | | b=−1.40 | −1.81 |
| | | S. | ..... | −1.325 | +0.02 | +0.03 | b′=−1.34 | −1·73 |
| | | S. | ..... | −0.950 | | | b=−0.91 | −1.17 |
| | | N. | −0.900 | ..... | −0.01 | +0.01 | b′=−0.94 | −1.21 |
| | | | | | $+0.124^{d}$ | +0″.160±0″.064 | | |

Probable error of single determination, 0″.180

### THE MICROMETERS OF THE COLLIMATORS.

These have adjusting screws (*a*) to rotate the box to make the wires vertical; (*b*) to alter the collimation of the movable wires; (*c*) to alter the collimation of the fixed wires. Also a screw to move the eye piece nearer to, or farther from, the objective.

The micrometer heads are divided into 100 parts, and every 10th part is numbered 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. There is no comb-scale of whole revolutions. The screws are not moved by turning a micrometer head; but the head is geared into a toothed-wheel, which projects from out the recess of the eye-end. This wheel can be moved by the finger with great delicacy. One revolution is equal to 70″.48 for collimator Y, and 70″.44 for X. There are 10 screw threads to each 2.15 m.m.

### RETICLES OF THE COLLIMATORS.

I had ordered two glass reticles (which were made for me by Professor ROGERS of the Harvard College Observatory) to be inserted by the Messrs. REPSOLD. They have an insuperable objection to glass reticles of all kinds, and while the glass reticles which I sent, were duly inserted, they also put in a very excellent reticle of spider lines. As both reticles could not be in the same plane they sacrificed the glass one. But it was possible, by reducing the length of the eye-piece tube to provide for seeing either of the reticles at will by simply changing the focus.

The glass reticles are precisely similar to those described by Prof. ROGERS in the *Annals of the Harvard College Observatory*, Vol. X, page XIV.

The spider line recticles consist of two fixed wires and of two movable ones. The distance of the fixed wires is 1.349 rev. ± 0.00008 rev. (112″.3) for Y, and 1.300 rev. ± 0.0008 rev. (111″.6) for X, and the distance of the movable wires is about 0.28 rev. (19″.6).

The spider line recticles of the two collimators are exactly alike. The lines of the glass recticles were not filled with plumbago by the REPSOLDS.

THE LEVELS.

The collimator levels are alike and are numbered R. (epsold) 1396 and R. 1399 respectively. Each bubble is divided on the glass into 62 equal parts and numbered 0, 10, 20, 30, 40, 50, 60. The hanging level is similar to the others.

The value of a division of the bubbles was given me by the REPSOLDS as below:

| | Hanging Level; | R. 1396; | R. 1399 |
|---|---|---|---|
| One Division= | 1".22 | 1".27 | 1".28 |

Determinations have been made here as follows:

*Hanging Level:*

| | | | | | |
|---|---|---|---|---|---|
| 1883 | Jan. 5 | 1".20±0.012; | t°=44°; | E. S.H. | from the circle. |
| | 9 | 1 .20±0.008; | =42 ; | " " | " " |
| | June 9-16 | 1 .29±0.005; | = ? ; | G.C.C. | " Ast. Nach. No. 2490. |
| 1884 | Feb'y 7 | 1 .28±0.009; | =27 ; | J. T. | " Z. D. Micrometer. |
| | 13 | 1 .22±0.007: | =20 ; | J. T. | " the circle. |
| | Feb'y 15 | 1 .31±0.003; | =15 ; | J. T. | " Z. D. Micrometer. |

Two determinations in January were made with the bubble attached to its frame. The determinations of June and February required that the level should be dismounted from its frame. It appears probable that this operation in June altered the bearings of the level bubble in the Y's of its case.

The determination of June 9–16 was made by the method of Dr. BRAUN described in *Ast. Nach.* 2490. The level-constant of the circle has not been above 2 div. and the uncertainty in the value of the level-constant has therefore always been less than 0".01.

R. 1396:—This level has not been changed in adjustment since it was received. The value of one division has been found:

| | | | | | |
|---|---|---|---|---|---|
| 1883 | Jan 9. | 1".31; | t°=42°; | E.S.H. | from the circle. |
| | 10. | 1 .29; | =45°; | " " | " " |
| | 30. | 1 .28; | =47 ; | " " | " " |
| | Adopted | 1 .29 at | 45° | | |

R. 1399—This bubble was turned slightly in its Y's and readjusted in December 1882. The value of one division has been found:

| | | | | | |
|---|---|---|---|---|---|
| 1883 | Jan. 10. | 1".41; | t°=47°; | E.S.H. | from the circle. |
| | 10. | 1 .45 | =47 ; | " " | " " |
| | 30. | 1 .49 | = ? ; | " " | " " |

An examination of this level in September 1883 led me to believe that the tube was under some slight strain and it was removed from its bearings and readjusted.

From three days (30 observations) Mr. TATLOCK found:

$$\text{One division} = 1''.225 + 0''.01\ (t - 32°).$$

It is clear that these levels require great care in placing them in their own Ys, in leaving equal portions of the ends projecting beyond the Ys etc. When this care is taken they give remarkably consistent results, and are truly instruments of precision, as so many levels are not.

The hanging level gives the same value of the level constant as the nadir observation.

Each collimator level is provided with a cross level. The most delicate of these has 1 inch=107″±. This seems to me too delicate. The level tubes are closed at the ends by melting the glass itself. This should obviate all leakage. Each has an air chamber. The value of one division of the collimator levels can be easily determined by setting them astride of the tube of the telescope and reading the levels as the telescope is moved in declination. Singularly enough, it is almost impossible to find a good way to attach the hanging level to the telescope or circles in order to determine the value of *its* divisions without detaching the bubble from the frame. In fact this was done January 5 and 9 by clamping a wooden axis to the upper part of the declination clamp, and removing the hand-circle to give room. By making two round surfaces on the handles which hold the illumination rods, the determination would have been made much easier. I have asked the makers to do this in a circle they are constructing for the Lick Observatory.

A very excellent device which cannot be explained without a wood cut insures that the levels should bear on the pivots with considerably less than their full weight. Incidentally this counterpoising gives a warning of the moment before the V's of the level touch the pivots and insures careful handling. Clamping the telescope has no effect on the level.

### EYE-PIECES OF THE MERIDIAN-CIRCLE.

A box of five eye-pieces, two sun glasses and a reflecting nadir cap (BESSEL'S form) was received from the makers. This last was especially ordered. The eye-pieces I have marked I, II, III, IV and V (diagonal). The powers and fields are as below:

| | | |
|---|---|---|
| I | power = 68 | field = 27′.9 |
| II | = 102 | = 19 .1 |
| III | = 144 | = 12 .2 |
| IV | = 174 | = 9 .2 |
| V | = 119 | = 10 .9 |

IV is generally used in observation.

The sunshades *screw* on the eye-pieces instead of fitting (slipping) over the end. The dark glasses are also tightly reamed into their cells and will therefore eventually break. The eye-pieces were ordered to be made Steinheil achromatics. They have been made after that formula, but *the fields are not flat.* I have replaced IV by a genuine Steinheil.

### THE OBJECT-GLASS AND ITS ADJUSTMENT.

This was made by ALVAN CLARK & SONS. It has a clear aperture of 4.80 inches, and a focus of 57.6 inches. The *minimum visibile* in a dark field is theoretically 12.6 mag. In a bright field it is practically 9.0 mag. with the spider-line recticle, and probably about 8.5 with the glass-recticle.

In March 1883, while I was absent, Mr. COMSTOCK focused the objective on the images of the wires seen in the Nadir-box. After my return in July 1883, the instrument was employed only in A. R. observations until August. Daily determinations of the Nadir, etc., were made by Mr. TATLOCK, assistant, as exhibited in the tables at the end of this paper. After August 28, to test the question of focal adjustment, the Nadir was determined in three ways at each convenient occasion:

1st, with the whole aperture.

2d, with the objective covered by a lune-shaped cap, with its aperture *north.*

3d, with the same cap with its aperture *south*.

This cap was made from a piece of card-board which was first cut into a circle of the same size as the objective. Then a circle was described from a point of the outer curve of the pasteboard circle as a center, which had the same radius as the objective. Then the portion of the pasteboard lying between the two circumferences, was removed. This left a lune-shaped aperture whose bounding curves were both concave towards its centre. This opening was turned alternately north and south. The results of the first determinations (August 28—September 5), were regarded as unsatisfactory, (see the table immediately following) although the images of the wires were good, and the images of stars were not noticeably bad, though not entirely satisfactory. I then changed the focus slightly. The observations of September 8, 11, 12, correspond to the change. I then arranged a mark south of the south collimator (a printed notice) so that it could be seen in the telescope of the circle after its rays passed through a large lens of ten inches focus. The cap was then moved so that the lune took the four positions, cap *up, down, right, left,* and the objective and its cell was so tilted that the image of the printed letters was the same in all positions of the cap, and also with the full aperture. I found that the objective needed a very considerable change to produce this result. It then gave good images of stars. The measures of September 16, 19 and 21 were taken in this state of the objective.

The first six measures give in the mean, Free objective *minus* ½ (Lune N. + Lune S. ) = +0.″22. The last three give for the same quantity + 0.″03. At the time this was regarded as a proof that the latter state of the objective was an improvement over the first, especially as the images of stars were then satisfactory.

In April, 1884, however, I began a series of observations of the 303 fundamental stars of the Astronomische Gesellschaft, and I found the images of stars were very unsatisfactory at this time, although there had been no change of the objective. An examination of the objective led me to

the conclusion that tilting it, by the insertion of pieces of card board between the base of the cell and the face-plate of the tube (which I had been obliged to resort to in the absence of adjusting screws for the cell) had slightly strained the lenses. The card board was at once removed and the cell was replaced in very nearly its original state. The images of stars were improved by tightening some of the screws of the cell and they are now (May, 1884) tolerably good.

A wing on one side of the image still remains, which could be removed in five minutes were the necessary adjusting screws available from the outside. The nadir points with the whole objective and from the means of the lunes now agree within 0.″2 and considering the difficulty of determining the nadir with the lune shaped aperture, I am now disposed to consider this satisfactory, which I was not at first.

It is my opinion that all objectives as large as 4.5 inches and upwards should be mounted so that 3 binding and 3 opposing screws (in pairs) are easily reached from the outside for their adjustment. No objective can stay in perfect adjustment forever, no matter how mounted.

If then it has to be corrected, some convenient means for doing this should be provided.

## NADIR-POINTS; DETERMINED WITH AND WITHOUT THE LUNE-SHAPED CAP.

| 1883. | Aug. 28. | Aug. 30. | Sept. 5. | Sept. 6. | Sept. 8. | Sept. 11. | Sept. 12. | Sept. 16. | Sept. 16. | Sept. 19. | Sept. 21. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lune S.... | 35″.76 | 35″.70 | —— | 36″.22 | 34″.57 | 35″.08 | 35″.44 | —— | 34″.62 | 34″.60 | 34″.57 |
| Lune N... | 35.01 | 35.18 | —— | 35.45 | 34.26 | 34.25 | 34.68 | —— | 34.68 | 34.43 | 34.35 |
| Free Objective . | 35.82 | 35.57 | 36.29<br>.41<br>.19 | 35.97 | 34.40 | 34.93 | 35.47 | 34.86*<br>35.03*<br>34.78* | 34.39 | 34.70 | 34.63 |
| O. G.—N.. | +0.81 | +0.39 | —— | +0.52 | +0.14 | +0.68. | +0.79 | —— | −0.29 | +0.27 | +0.28 |
| O. G.—S.. | +0.06 | −0.13 | —— | −0.25 | −0.17 | −0.15 | +0.03 | —— | −0.23 | +0.10 | +0.06 |

Focus altered Slightly. (Sept. 8 – Sept. 12)

Whole objective Altered. (Sept. 16)

The observer throughout is TATLOCK except those observations marked *, when it is COMSTOCK.
The probable error of a single determination of the Nadir point has (elsewhere) been shown to be ±0″.15.

We have not yet examined the question as to whether the Nadir point is the same when the telescope is turned from the north to the Nadir or from the south to the Nadir.

To protect the mercury in the Nadir-box against currents of wind in the room, I use a screen of 2 joints of tin furnace pipe 12 inches in diameter, and find advantage from this.

The Chicago, Milwaukee & St. Paul R. R. has a track within 1,200 feet of the observatory, and the passage of a train interrupts all reflection observations for 5 minutes. But little inconvenience has so far been experienced from this.

### ILLUMINATION OF THE FIELD OF VIEW IN THE DETERMINATION OF THE NADIR-POINT.

The general practice is, I believe, to employ a cap over the eye-piece which has a plane glass reflector above it. The image of a lamp flame is reflected into the field and on this image the position of the reflected wire is measured. The field is of various brilliancy in different parts, owing to the reflection from the two surfaces of the glass, etc., and this is often annoying and always fatiguing to the eye. I have found that by interposing a screen of ground glass, or even one or two thicknesses of oiled silk, between the flame and the reflector, a uniformly illuminated field is obtained, and the improvement is so great that I think it worth while to mention it here.

### THE MICROMETER OF THE CIRCLE.

The micrometer is, in general, a beautiful piece of design. To fully comprehend it, a figure should be given, which I have no way of producing here. The general principles of this form are the same as those which have been explained by Mr. DAVID GILL, in Vol. II, of the Dun Echt observations, and more specifically in the Encyclopædia Britannica, volume XVI, page 246, *et seq.* Figures 16 and 17 of that work give the essential features of our Z. D. micrometer. Figure 14 applies to the micrometers of the microscopes. I entirely agree with Mr. GILL in his admiration for the very elegant design and workmanship of these instruments. I may therefore content myself with pointing out some of the special

features of the exterior, and as usual, I shall speak most of the faults, as they appear to me.

The R. A. micrometer has no way of counting whole revolutions. This is always an inconvenience, and will be especially so in this case, where it is proposed to move the whole reticle (of glass) and to set it at the zero of collimation. A simple comb-scale would have been sufficient. Both micrometer heads are divided to 100 parts, and numbered 0, 5, 10, 15, 20, etc. That is, every fifth part is *numbered*. Experience has shown that ten parts are easily carried in the head, and I cannot but think that this numbering will produce a number of errors of 0.05 revolutions in the record. After a trial of it, I have had every number ending in 5 painted over in black paint.

The screw heads for giving the slide which carries the eyepiece a rapid movement, are particularly convenient. They consist of a small hexagonal head, which will move quite freely and rapidly between the fingers. The same kind of a head has been applied to the clamp of the main circle in Z. D., and here it is a mistake. Such a form is admirable for a rapid and continuous motion, as in the micrometer, but not at all suited for a motion of a tenth of a turn, such as is required to clamp the circle. In the latter case the object of the makers was evidently to provide against too much power being used on the clamp. Both of the micrometer heads of the eyepiece end have these little hexagonal heads for the purpose of giving a rapid motion to the screws; and for the purpose of making the final, fine setting, they have also milled heads about one inch and a third in diameter. The R. A. micrometer is provided with a clamp by which it can be fixed in any position. The (single) zero mark on the index of the R. A. micrometer, and the corresponding marks on the indexes of two of the microscope-micrometers are straight lines, or nearly so, but they are put on to the indexes so that they must always be *inclined* to the graduation.

On the whole, this micrometer seems to me to be superior in design to any similar one that I have ever seen, and in

particular it is better than the PISTOR and MARTINS micrometer in many essential ways.

One revolution of the Dec. screw is 64.″527, which is fine enough. One revolution of the R. A. screw is 4ˢ.295=64.″43. Each screw has 10 threads to 4.55 millimeters.

On Dec. 4 and Dec. 5, 1883, Mr. TATLOCK and myself investigated the periodic errors of the Z. D. micrometer for every tenth of a revolution from 4.0 to 15.0, by BESSEL'S method. On Dec. 4 a constant space of about 0.5 revolution was measured, and on Dec. 5 a space of 0.25 rev. The results showed the maximum periodic error to be not more than 0″.05. This is less than the least reading of the head (0ˢ001=0″.06) and less than the accidental errors of setting, and it will not be taken into account. This result has somewhat surprised me, as the form of mounting gives the errors of the screw their full value, the excellence of this form consisting in the fact that these errors, whatever they are, are *constant*. This determination will be repeated.

VALUES OF ONE REVOLUTION OF THE RIGHT ASCENSION AND ZENITH DISTANCE MICROMETER.

Four series of determinations of the value of 1 revolution of the Z. D. micrometer have been made.

I. Made by Mr. COMSTOCK on April 1st and 27th, 1883. The resulting value, from seven determinations, is, 1 rev.=64″.4799±0″.0026.

II. Made by Mr. COMSTOCK on June 22d and 23d, 1883. The resulting value, from ten determinations, is, 1 rev.=64″.5023±0″.0044.

III. Made by Mr. TATLOCK on July 14th and 16th, 1883. The resulting value, from ten determinations, is, 1 rev.=64″.4721±0″.0057.

IV. Made by Mr. TATLOCK on Sept. 24th, 25th and 27th, 1883. The resulting vale, from twenty determinations, four of weight ½, is, 1 rev. =64″.5215±0″.0075.

Between the times of these determinations the focus of the telescope was changed, and in order to combine the above values it is necessary to apply a correction to the first three in order to reduce them to the same focus with which IV was determined. The focal length of the telescope is taken as 56.9 inches, the approximate value of 1 rev. of the screw is 64″.5. I. requires to be corrected for a change of the focus

of 0.06 inch, and II. and III. for a change of 0.03 inch, the focus having been shortened 0.06 inches in all.

The corrections to I, III and II, computed from the formula,

$$dr = -64''.5 \frac{df}{56.9}$$

are then

| | |
|---|---|
| I | $+0''.0680$ |
| II | $+0\ .0340$ |
| III | $+0\ .0340$ |

The corrected values of the four determinations are:

| | | |
|---|---|---|
| I | $64''.5479 \pm 0''.0026$ | weight 1 |
| II | $.5363 \pm 0\ .0044$ | " 1 |
| III | $.5061 \pm 0\ .0057$ | " 1 |
| IV | $.5215 \pm 0\ .0075$ | " 2 |

The adopted value of 1 rev. of the Zenith Distance micrometer is:

$$64''.527 \pm 0''.0025$$

In March April and May 1883, Mr. COMSTOCK determined the value of 1 revolution of the A. R. micrometer screw, from thirty transits of circumpolar stars to be:

$$4^s.2904 \pm 0^s.005$$

As these determinations were made with the same focus as series I of the Z. D. micrometer, and as the values of the two screws are about the same, this value of the A. R. screw requires the correction of

$$+0^s.00045$$

The adopted value of the A. R. micrometer is

$$1 \text{ Rev.} = 4^s.295 \pm 0^s.0005$$

### RETICLES OF THE MERIDIAN-CIRCLE.

The REPSOLDS have, as has been said, an insuperable objection to glass reticles, and they inserted spider lines, besides providing for the glass reticles which Professor ROGERS ruled for me. None of the glass lines were filled with plumbago by the REPSOLDS. One serious objection to glass reticles is that, so far as I practically know, a dark field and bright wires can not be obtained. In every other respect they seem to me immeasurably superior to spider lines. The wires are far finer. For example: the spider lines of REPSOLD are

at least three times as thick as the lines of my glass reticle, which (when they are filled with black lead) are of a beautiful fineness, evenness and distinctness. Any amount of work can be put on determining the intervals of a glass reticle, tables may be constructed for these intervals at each 10′ of declination, and so on, since one is sure that it can never be broken except by gross carelessness, whereas spider lines change their distance from time to time (see LEYDEN observations, I p. xcvi for one example), and they perpetually need attention to keep them free of dust, and they are certain to be broken sooner or late.

The operation of replacing them is not easy, even if one has a suitable web. One glass reticle ought to last a hundred years. For reticles where inclined lines, two lines at an angle, etc., are required or convenient, as in some forms of collimator reticles, the glass wires have a greater advantage even.

DETERMINATION OF THE THREAD INTERVALS OF THE RETICLES, BY MISS ALICE SANBORN, STUDENT IN ASTRONOMY.

"The spider line reticle consists of two fixed horizontal guide wires and three parallel threads movable with the declination screw, also 27 fixed perpendicular threads, with one movable thread attached to the Right Ascension screw. For convenience I have lettered the groups of wires from A to G, beginning at the side nearest the Right Ascension screw. I have also numbered the wires of each group, in a like manner, from 1 to 3, 4 or 7, as the case might be. In the follow- measurements of the thread intervals the groups A and G are omitted because the movable thread cannot be brought to them. The coincidence numbers are the mean of two readings which indicate the contacts on both sides of the threads. Five sets of determinations were taken, no two of them upon the same day. Each set consists of 5 coincidences upon each of the 21 threads. So that the mean micrometer reading for each thread is a mean of 25 determinations. The measures were all taken in the daytime, the eyepiece being removed from the telescope and directed towards a window. The screw, when the readings were made, was always placed in the same position with reference

to the direction of gravity. The settings were made by increasing readings of the scale and between the horizontal guide wires.

The measures were taken between December 1st and 20th, 1882. The temperature where the micrometer stood during that time, ranged from 58° to 73° F.

The result of the investigation is summed up in the following table:

| Thread. | Mean reading of micrometer. | Distance from Mid. thread ($D_4$) in screw revolutions. | Thickness of thread in screw revolutions. |
|---|---|---|---|
| $F_4$ | 0.592±0.00063 | —7.050±0.0007 | 0.0239±0.0007 |
| $F_3$ | 1.057±0.00066 | —6.585±0.0007 | 0.0240±0.0005 |
| $F_2$ | 1.527±0.00095 | —6.115±0.0014 | 0.0242±0.0005 |
| $F_1$ | 2.006±0.00099 | —5.636±0.0010 | 0.0249±0.0005 |
| $E_3$ | 3.878±0.00064 | —3.764±0.0007 | 0.0242±0.0009 |
| $E_2$ | 4.348±0.00064 | —3.294±0.0007 | 0.0244±0.0008 |
| $E_1$ | 4.822±0.00071 | —2.820±0.0008 | 0.0240±0.0007 |
| $D_7$ | 6.704±0.00039 | —0.938±0.0005 | 0.0241±0.0006 |
| $D_6$ | 6.930±0.00054 | —0.712±0.0006 | 0.0232±0.0009 |
| $D_5$ | 7.170±0.00037 | —0.472±1.0005 | 0.0245±0.0009 |
| $D_4$ | 7.642±0.00039 | ..... | 0.0239±0.0009 |
| $D_3$ | 8.116±0.00037 | +0.474±0.0005 | 0.0249±0.0006 |
| $D_2$ | 8.355±0.00037 | +0.713±0.0005 | 0.0237±0.0009 |
| $D_1$ | 8.606±0.00039 | +0.964±0.0005 | 0.0243±0.0005 |
| $C_3$ | 10.472±0.00058 | +2.830±0.0006 | 0.0242±0.0005 |
| $C_2$ | 10.938±0.00074 | +3.296±0.0008 | 0.0234±0.0005 |
| $C_1$ | 11.406±0.00120 | +3.764±0.0012 | 0.0222±0.0006 |
| $B_4$ | 13.302±0.00083 | +5.660±0.0009 | 0.0226±0.0007 |
| $B_3$ | 13.776±0.00062 | +6.134±0.0007 | 0.0225±0.0005 |
| $B_2$ | 14.239±0.00058 | +6.597±0.0006 | 0.0231±0.0006 |
| $B_1$ | 14.718±0.00101 | +7.076+0.0010 | 0.0230±0.0003 |

These may be reduced to arc by the relation:

$$\text{One revolution} = 4^{s}.295 \text{ in time.}$$
$$= 64''.43 \text{ in arc.}$$

The glass reticle was ruled by Professor W. A. ROGERS. It has 21 lines arranged in 5 groups of 1, 3, 13, 3, 1 lines; these groups are called L; M; O; P; Q. The equatorial intervals, as measured with the micrometer screw are:

$$\begin{cases} Q = -20^{s}.06 \\ P_3 = -12.03 \\ P_2 = -10.10 \\ P_1 = -8.04 \\ O_{13} = -4.04 \\ O_{10} = -2.02 \\ O_7 = -0.00 \\ O_4 = +2.01 \\ O_1 = +3.93 \\ M_3 = +8.02 \\ M_2 = +10.04 \\ M_1 = +12.06 \\ L = +20^{s}.10 \end{cases}$$

The spaces between $O_1$ and $O_4$, $O_4$ and $O_7$, $O_7$ and $O_{10}$, $O_{10}$ and $O_{13}$, are divided into 3 equal parts by short intermediate lines. For *Polaris* these smallest intervals correspond to about 30$^{s}$."

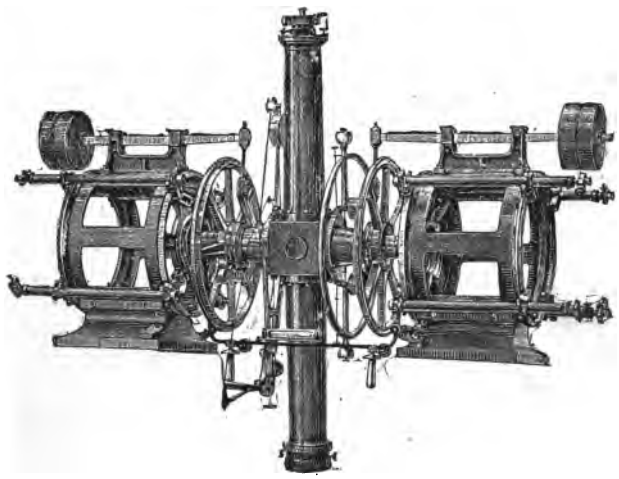
THE DECLINATION CLAMP.

The cut will give a better idea of this than any description. One turn of the slow motion in Declination is 4′ on the circle. The clamp is radial, and its head is hexagonal 0.5 inch in diameter. This head is too small, and I have made it larger by wrapping a wide rubber band about it. Clamping or unclamping has no effect on the pointing, as there is an adjustment by which the slack motion can be taken out.

THE ILLUMINATION OF THE FIELD OF VIEW.

The handles for controlling this are on the side of the telescope opposite to the clamp in declination. Both bright and dark wires are provided for. When the eye and object ends are interchanged, no change is necessary in the illumination arrangements. At least this was the intention of the makers. The probability is, however, that the changed adjustment of the objective will necessitate a change of this sort.

Within the cube is a frame carrying two mirrors. This frame is movable by the handle for bright wires. With *circle east* the beam from the west lamp is reflected by the west mirror to a small circular mirror (0.43 inch in diameter) fastended to the inner surface of the objective, and from this toward the eye-end, giving a bright *field.* If bright *wires* are wanted a few turns of the bright wire handle reverses the mirror-frame and turns the west mirror out of the way of the beam from the west lamp. This beam then falls on the *east* mirror and it is reflected to prisms on each side of the tube near the eye-end, which light the wires symmetrically. Each mirror is adjustable, and the angle through which the mirror-frame rotates is also adjustable. I do not know how the illumination is modified in intensity, as the apparatus is concealed in the cube. It is probably quite simple.



THE AXIS.

The axis consists of one piece of brass (gun metal?) with steel pivots in each end. In the center of the axis is the *cube,* 6.9 inches on each edge. Next to the cube, on each side, is a narrow cylindrical band, which holds the Dec. clamp on one side and the illumination handles and two counterpoises to the clamp on the other. Beyond this is a conical axis J F, J being nearest the cube. The diameter at J on the clamp

side is 5.34 inches, on the other 5.36 inches. (Cl. — O = — 0.02 inches) The diameter at F is clamp side 4.26 inches, other side 4.23 inches (Cl. — O = + 0.03). Beyond F is a cylinder E, on each side, which takes the rolls of the counterweights. The diameters on both sides are 5.96 inches. (Cl. — O = 0.00). The distance from the centre of the cube to these rolls is 9.3 inches; from the rolls to the centre of the bearing surface of the pivots, 5.2 inches. The two circles fit on two slightly conical surfaces C, and rest flat against the outer surfaces of E.

The diameters of C where it joins E, are 4.25 inches on both sides (Cl. — O = 0.00). Beyond C is a conical solid Y Z, Y being nearest the cube. The diameters at Y are, clamp side 3.40 inches, other 3.34 inches, (Cl. — O = + 0.06 in.) The diameters at Z are, clamp side 3.05 inches, other 3.00 inches, (Cl. — O = + 0.05 in.) Beyond Y Z is a cylinder D, of the diameter 3.21 inches on both sides. Into D the pivots are inserted. The apertures in the cube are 3.1 inches in diameter; the collimator objectives are 2.7 inches.

### THE TUBE.

The tube is made of two sections of heavy brass, bolted to the cube by eight screws at each section. Each section is 22.8 inches long, the cube being 6.9 inches. Both ends are alike, and the cell of the objective, or the eye-piece can be screwed (by three screws) to either end. The 16 capstan-headed screws which bolt the tube to the cube have holes of *different* sizes. Eleven of them will take the capstan bar sent by the REPSOLDS, and the rest require a smaller bar!

### THE PIVOTS.

The steel pivots are beautifully polished, with bearing surfaces 0.9 inches long. Beyond these, nearer the cube, are two unpolished surfaces 0.6 inches long. These last allowed the grinding tool to pass completely off the pivots proper. I have never seen work of the kind more beautiful to the eye. The pivots are protected from dust by brass caps, which are removed for level determinations.

The circle is raised and the pivots examined every Mon-

day. At first I allowed the pivots to run dry. They are now covered with fine watch-oil.

During the winter of 1882–3, one of my students, Mr. C. M. CONRADSON, of the University of Wisconsin, made a very extensive and careful set of measures of the pivots A. and B. A is the pivot next the clamp.

The measures were made with a caliper constructed by FAUTH & Co., of Washington, from the designs of Prof. HARKNESS (Mon. Not. R. A. S. vol. 38, p 487.)

A figure of this is given on the next page.

In the first place, the pivots were proved to be circular, by measures of diameters inclined by angles of 45°. Each pivot was accurately circular. The pivots are very approximately 1.333 inches in diameter.

To determine whether the two pivots were of the same diameter, the following measures were made by Mr CONRADSON. Each line in the table represents 10 measures on A. and 10 on B. There are 200 in all. The measures of each day are given in the following table. + in column 4 indicates Clamp Pivot too small.

| 1882. | A. Revolutions. | B. Revolutions. | A—B. Revolutions. |
|---|---|---|---|
| December 7..... | 0.006389 | 0.006383 | +0.000006 |
| 7..... | 6312 | 6386 | — 74 |
| 8..... | 6400 | 6399 | + 01 |
| 11..... | 6398 | 6414 | — 16 |
| 11..... | 6380 | 6368 | + 12 |
| 11..... | 6369 | 6360 | + 09 |
| 12..... | 6300 | 6367 | + 67 |
| 12..... | 6336 | 6367 | — 31 |
| 12..... | 6340 | 6354 | — 14 |
| 12..... | 0.006382 | 0.006379 | +0.000003 |
| | | Mean ..... | −0.0000171 |

Let 2i=the angle of the Ys of the caliper=90°.

n=the difference of the spherometer readings on the pivots A and B$=0.0000171^{rev.}$.

$r_1$, $r_2$=the radii of the pivots.

Then the inequality of the pivots expressed in revolutions of the spherometer is

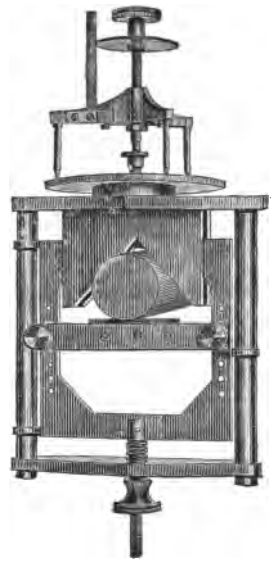
$$r_1 - r_2 = \frac{n. \sin i}{1+\sin i}$$

$$= 0.414\ n \text{ in the present case.}$$

$$= 0.000007 \text{ revolutions.}$$

One revolution was 0.010017 inches whence the *indicated* difference of diameters of A and B is 0.000,000,07 inches.

It is clear that there is no measurable difference in these pivots. They are, like nearly every other essential part of the instrument, very near to mechanical perfection.



CIRCLES.

Each circle fits neatly on its bearing (the divided circle the tightest) and is kept in place by a plate or ring of brass which is held by four screws which do not touch the circle itself. Thus the circles can be moved on the axis and they are under no strain. Each circle has eight spokes and the microscope bearers have six. As far as I can see the flexur e of the circles would be less if they were composed of single plates. One circle is divided on silver to 2′. The marks for each degree and for 30′ are of one length; those for 10′ are

shorter; and those for 2′, 4′, 6′ and 8′ are shorter still. The divisions are extremely neat sharp and regular in appearance. The width of each division is about 11″. The width of the divisions of different circles (of various diameters) vary considerably. PISTOR & MARTINS' circle at Washington has divisions 4″ in width. The Harvard College Circle has divisions 12″ wide. The REPSOLD circle at Moscow has divisions 5″ wide. I presume the more oblique illumination of the PISTOR & MARTINS' circle to have something to do with the difference, although the divisions themselves are really far narrower. The probable error of a single microscope setting is 0″.16. This is the same for the long as for the short divisions, at least for myself. Each degree is numbered (this had to be especially ordered) and the numbers are wrong side up. The numeration increases like that of the face of a watch. The diameter of the division is $0^m.55$=21.65 inches. 1°=0.189 inches; 2′=0.0068 inches. It required 58 hours to divide the circle.

The division itself is on a narrow band of silver whose surface is approximately flat. On each side of the band is a continuous groove extending all round the circumference. This is probably intended to receive dust, etc., and to keep it away from the divisions.

The circle was not critically examined throughout its arc, until some time had elapsed since the mounting of the instrument. When it was examined (January, 1883) I found a large number of places on the divided limb which showed fine scratches usually not visible in the reading microscopes however. I am not certain, of course, that these were not made here, but the divided circle was not put on the axis till December 1882, and since that time it has been very carefully treated. It was only removed from its box at the time of putting it on. No one of these is more than the finest line, and as I said only one or two are visible (even) in the reading microscopes. I have made a list of the places where they occur, and can by consulting this see if similar ones are produced in the future.

### THE HAND-CIRCLE.

This is of round brass tubing made in two halves, which are bolted to squared surfaces on the holder for the illumination-handle.

At first the circle was often moved in Z. D. by taking hold of the eye-end of the tube. Now, the invariable practice is to move it by the hand-circle, and it appears that this custom has slightly improved our declinations.

### COUNTERPOISING.

The counter weights (four in number) are held by two levers over the Vs, which rest on knife edges. They have been so adjusted (by a spring-balance) as to leave nearly 12 pounds pressure on each V. In this state, a weight of about one pound applied to either end will just keep the telescope moving. The whole friction is in the Declination arm. If this is put out of gear a few ounces will move the telescope.

### CHAINS FOR HOLDING THE COUNTERWEIGHTS.

A criticism which has been made upon the style of microscope holders adopted by the REPSOLDS, is that during reversals the weights above the piers are quite differently disposed from common. To obviate this objection, the makers provided two chains which fasten to the wooden casings (to the W. side of the E. pier and to the E. side of the W. pier), and extend vertically upwards to take hold of two eyes in the under sides of the hooks which hold the friction-rolls. The idea seems to be excellent, but it is a fact that few circles are reversed oftener than once a month, and in my own case I do not propose to reverse oftener than four times per year. In order to be ready for such occasions these chains have to be kept hanging to their fastenings where they are very much in the way, or else they must be newly adjusted for each reversal.

By reversing at the end of one night's work, the piers, etc., will have plenty of time to settle to new and permanent bearings before the next observation. Therefore I have (at least for the present), left off these chains, in order to have the space between the piers clear.

THE PIERS FOR THE INSTRUMENT AND COLLIMATORS.

A plan and an elevation of the piers was furnished by the REPSOLDS and exactly followed throughout.

The order of work was as below: A meridian line was marked on the north and south walls, and perpendiculars to this were marked on the east and west walls. A full size section of the piers was drawn on the west wall and centres carried across to the east wall. The foundations for the piers of the PISTOR and MARTINS Transit belonging to Professor WATSON, were already laid, and these were utilized as a basis for the piers of the REPSOLD meridian circle. 7′ 4″ below the floor a thin bed of concrete had been laid (about 2″ thick). This rested on a level bed of the fine building sand of which the hill is composed. On this concrete was a mass of rubble stone 2′ 6″ high, by 4′ 6″ wide (north and south), by 8′ 10″ long (east and west). On this was a mass of solid brick-work (white Waterloo brick laid in cement), 2′ 0″ × 4′ 6″ × 8′ 6″. Above this was a single granite block, 10″ × 4′ 6″ × 8′ 6″. Up to this point no new work was done. The surface of this stone was cleared off and 3 courses of hard red brick were laid on it. The east and west dimensions were about 8′ 4″. The height was 10″. The width at bottom was 3′ 6″, at top 3′ 0″. The top was 11″ below the floor level.

This whole foundation was surrounded by an open pit some 16″ wide whose bottom was 7′ 4″ below the floor. A 9″ brick wall surrounded this pit. No collimator piers were provided for the old Transit Instrument and these were therefore entirely new. The foundations for the collimator piers start from a plane 8′ 9″ below the floor and are based on a bed of concrete 5″ thick. On top of the concrete (which does not touch any of the walls of the building, nor any of the walls of the well around it) three courses of red brick are laid with the sides vertical. This block is 10″ × 4′ 6″ × 4′ 9″. Above this is a frustum of a pyramid 4′ 6″ square at the bottom and 3′ 3″ square at the top. The top is 11″ below the floor level. Each collimator foundation is in a well, surrounded by a 9″ brick wall, whose bottom is 8′ 9″ below the

floor and whose top is 2′ 0″ below the bottom of the flooring joists, which are supported on this cross wall. The piers of the instrument and of the collimators are thus insulated from each other. Perhaps in such a soil as ours, fine building sand, as was said, this is the best disposition; but at any rate it was necessitated by the nature of the case. The *foundations* were thus brought to a level surface 11″ below the floor, and on these the piers were constructed from the plans furnished by the Messrs. REPSOLD.

Each collimator foundation contains 3,072 brick; the bricks weigh 4.48 pounds; and thus each collimator pier foundation weighs 13,760 pounds or nearly seven tons.

The foundations for the two collimators, and the single foundation of the two piers of the instrument having been brought to one level, the tops of these foundations were coated with a thin layer of plaster of Paris, and on this layer an accurate plan of the base of each of the four piers was drawn. The meridian and the prime vertical were also accurately laid down. Over the foundations a firm scaffolding was erected and frames for each of the piers were built; and the brick work was made to fit these frames. The piers themselves were built of hard, selected red brick, taken from near the arch of the kiln. Only Portland cement was used in their construction. All joints were broken, and every fifth course was a heading course. In each course, each brick of either of the two collimator piers or of the two instrument piers, has another brick in the corresponding collimator or instrument pier, symmetrically situated with respect to the meridian and the prime vertical. This applies even to the pieces which are less than the dimensions of a whole brick. That is, if you select any particular brick, either whole or cut, in any course of the north collimator pier, whose center is $a$ inches north and $b$ inches east of the center of the mercury basin, you can find another brick or part of a brick, of the same size as the first, in the south collimator pier, whose center is $a$ inches south and $b$ inches west of the center of the mercury basin. It was found to be quite as easy to build in this way as in any other. The piers of the instrument are similarly laid. The dimensions of the piers are as follows:

The piers for the instrument are 59.06 inches high (above the floor); those for the collimators are 66.73 inches. The dimensions of the piers of the instrument, on top, are 19.69 inches square. Eleven inches below the floor they are 33.07 inches square. The collimator piers on top are 31.89 inches (north and south) by 15.75 inches (east and west). Eleven inches below the floor they are 33.86 inches (north and south) by 33.07 inches (east and west). The distance from the center of the circle piers to the nearest faces of the two collimator piers is 70.87 inches. Each pier has a wooden casing made of alternate strips of white pine and black-walnut about $\frac{3}{4}$ inch thick. Each case is made in four sections, screwed together at the angles, and confined at the top by a cornice of walnut. At the bottom each section is screwed to a batten fastened to the floor. The inside of these cases is lined with tarred paper tacked to each section. Each instrument pier was covered with double face canton flannel confined round the top by thin wooden strips and cut in four pieces hanging loosely down each face of each (instrument) pier. Each of the four piers was also protected from change of air by a strip of flannel several times doubled, one edge of the strip being tacked to the floor, the other edge lying loosely against the bottom course of bricks.

These precautions enable us to preserve a layer of the best non-conductor, unchanged about the surfaces of the piers. To show how efficient this simple plan is, I cite the following experiment: I had a mass of smoke-producing material put in an open pan in the cellar below the piers for the instrument and lighted. Volumes of smoke were produced and maintained. These would instantly rush up through any opening made in the floor itself, but $2\frac{1}{2}$ minutes was required for the slightest sign of smoke to manifest itself in the open space between the top of the piers and the cornice of the wood cases. Practically we may say we have a constant layer of air confined about these piers. After some six months trial it was found that the collimator piers (which were not *wrapped* in flannel) were much drier, and that their wooden cases had warped less than those for the instrument; and the cause of this was believed to be that the

flannel absorbed and retained the moisture of the air in the cellar. The flannel *wrapping* was removed (December 1882) and additional folds of it were tacked to the flooring joists around each of the instrument piers, so that the loose ends of the flannel rested against the bases of the piers.

### THE OBJECT GLASS AND ITS CELL.

The objective is by A. CLARK & SONS. Its clear aperture is 4.80 inches — 122 millimeters. Its focus is about 57.6 inches. The *inner cell* which holds the objective, is held to the *outer cell* which goes into the objective-end by 3 screws. Two steel springs push a loose block of the outer cell towards a bearing surface opposite. If the springs alter their tension with changes of temperature the change in collimation will be in *declination* only. The Nadir Point and not the collimation constant will be affected. In fact the Nadir-Point does change with changes of temperature. Two screws are provided which screw into the object-end and serve to handle it by. When they are removed the cap will cover the cell.

The two cells (inner and outer) above described fit into what I have called the object end. This is fastened by 3 screws to the face-plate of the tube, and it is interchangeable (in five minutes) with the eye-end.

### ARC FOR SETTING THE CIRCLE.

Following the example of Professor ROGERS of the Harvard College Observatory, I have had a wooden arc 34.7 inches long, 3.6 wide, screwed flat against the wooden casing of the east pier. The radius of the arc is about 60 inches, and it is to be read by a long pointer (counter-weighted.) The arc itself is made of three thicknesses of veneer, to prevent warping; the two outer ones are of seasoned maple, the middle one of curled French walnut.

### MICROSCOPES.

There are 8 microscopes, 4 for each pier. They have been numbered I, II, III .... VIII *here,* since it is necessary to distinguish them. The microscopes are 23.5 inches long. They are made of iron, with brass micrometers. They are held to the bearer by two iron clamps, one at each end. The clamp

nearest the objective can be loosened from the microscope; the other not easily. The former has 3 opposing screws (2 and 1), by means of which the adjustments are made, when the (single) screw of the eye-end-clamp is loosened. The focus of the objective can be changed; and by means of two opposing screws in the iron tube the microscope objective can be moved across the tube, so as to bring the image of the division to the cross wires. Thus the microscopes are very easily set just 90° apart. The objective is covered from dust by a little sliding cap. The micrometer can be rotated, and after rotation it can be fixed in position. The steadiness of the microscopes can be seen in the table of microscope distances at the end of this paper. The microscopes magnify 36 diameters. The probable error of a single setting is $\pm 0''.16$. The micrometer head is divided into 60 parts. One part $=1''$. The screws have ten threads to each 2.05 millimeters. The head is *numbered* at every 5th part, thus 20, 25, 30, 35, etc. This plan is certainly not a good one. The numbering should be at every 10th division. I have covered every 5th number with a small square of black paint. The field of view of the microscope covers about 49′ on the circle. It contains one fixed wire to mark the center of the field, and two *pairs* of moveable wires AA′ and BB′ perpendicular to the fixed wire. The distances AA′ and BB′ are about 30″. The width of a division is about 11″. The middle of AA′ is 90″(=1½ revolutions) from the middle of BB′. A comb scale of five teeth counts the whole revolutions. Ten revolutions is the middle tooth, and 12, 11, 10, 9 and 8 revolutions are marked. The pair of wires *nearest* the divided head is alone used in our practice.

By this arrangement of the wires, first suggested by MARTH, (*Ast. Nach.*, 1262 q. v.,) the errors which return once in a revolution can be eliminated in a simple manner. The pair of wires A is to be brought successively over two circle-divisions to the *right* (say) of the Zero of the comb scale, and the pair B successively over the two divisions to the *left*.

An examination of the microscopes V and VI showed that the periodic error was quite below the accidental errors of

reading. The other microscopes have not yet been investigated.

The 8 microscopes are marked I ..... VIII. When the circle is east microscopes I ..... IV are employed and the reading of the circle *increases* from I to IV.

| | | | | | |
|---|---|---|---|---|---|
| I | is | the | lower | northern | microscope; |
| II | is | " | " | southern | " ; |
| III | is | " | upper | " | " ; |
| IV | is | " | " | northern | " ; |

For circle west: the reading *increases* from V to VIII; —

| | | | | | |
|---|---|---|---|---|---|
| V | is | the | lower | southern | microscope; |
| VI | " | " | " | northern | " ; |
| VII | " | " | upper | " | " ; |
| VIII | " | " | " | southern | " ; |

In both positions of the circle the following scheme gives the divisions under each microscope.

| Setting / Microscope. | I. / V. | II. / VI. | III. / VII. | IV. / VIII. |
|---|---|---|---|---|
| Z | Z—44° | Z+46° | Z+136° | Z+226° |

*Circle East*; The south stars have the greatest reading;

*Circle West*; The south stars have the least reading.

### ADJUSTMENT OF THE MICROSCOPES.

I. The microscopes should be 90° apart. This is effected by moving the clamps holding the eye and object end of each.

II. Two revolutions of their heads should be 120″. This is effected by moving the eye-end out or in, and focusing on the circle; at the same time moving the objective.

III. The line joining the zeros of each pair of microscopes should pass through the axis of the meridian circle and the plane containing the line and axis should contain the optical axis of the microscope. This can be tested by moving the

axis bodily east and west, and the REPSOLDS have provided a slow motion screw which moves the end (contact) levers which abut on the ends of the pivots. When the circle is east, loosen the clamping screws to both the contact-levers, and move the slow-motion screw of the east one. If the adjustment is not correct, a parallax is produced which must be eliminated.

### ILLUMINATION OF THE MICROSCOPES.

This is the best I have ever seen; and the only illumination which can be said to be perfectly satisfactory. The beams from the lamps fall on four mirrors (adjustable) symmetrically disposed about the axis of the instrument on the frame of the microscope bearers.

These mirrors throw beams upon four other mirrors, one fastened to each microscope. Each of these latter mirrors throws its beam along the axis of its microscope on the graduated limb. The beam from the lamp opposite to that which lights the microscopes, goes directly into the axis of the circle to light the field of view. A part of the beam from the lamp illuminating the microscopes is reflected down by two fixed reflectors to illuminate the field of view of the setting microscope, and it *directly* illuminates the *heads* of the micrometers, thereby saving all the annoyance of hand lamps. This illumination is so simple and so good that it should take the place of every other.

It should be mentioned that the shadow of the bolt let in each brick pier and of the nut (on this bolt) which fastens the pier-head to the pier, is *necessarily* thrown on the mirror for illuminating the setting microscope. If a hole had been countersunk in the plate below the nut, the quantity of light available would have been greater. I have remedied this difficulty by sawing off part of the bolt and by covering one of the metallic mirrors with a piece of looking-glass.

### SETTING MICROSCOPE.

This rests in Ys which are fixed to the east or west pier-head, and the microscope is shifted according as the circle is east or west.

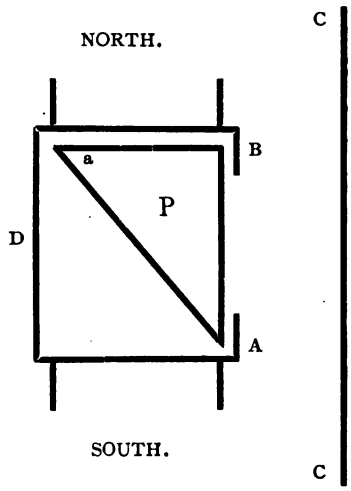
It has two prisms in its center that reflect the rays moving east (say) from the limb towards the north *and* south, and the two eyepieces view the limb. The field of view is 2° 10′, and as *every* degree is numbered, two degree numbers are always visible, and hence one is sure of the direction of increasing graduation, and can read between two marks. The illumination is perfectly simple in principle, and in practice it has been made satisfactory, as just explained, by replacing one of the metallic mirrors by a silvered glass reflector.

When the circle arrived I did not take the setting microscope apart, but by a slight adjustment I fixed the setting microscope prisms so as to make the reading the same when the observer was looking north or south. Since July 1st Mr. TATLOCK has used the north end of the setting microscope exclusively, so that it was not until December, 1883, that I discovered that the two settings were several minutes different, and was led to take the microscope apart, and to discover what seem to me radical defects in its design. As these are important, I will briefly indicate them. The two tubes of the north and south halves of the setting microscope end in a cubical box of brass, which contains the two prisms which reflect the light from the limb of the circle towards the north and south. Each prism rests at one end (which I shall call the pivot end) on a little strip of tin-foil; at the other end it rests on the point of a small brass screw (the adjusting screw). The head of this screw can be reached from the outside of the cubical box. Moving it in rotates the prism about its pivot edge. Both prisms are pressed down upon the adjusting screws and the tin-foils by a piece of sheet brass bent in the form of a V, which is put in the cubical box at the part furthest from the circle. The point of the V rests upon the back of the box (which can be removed); the legs of the V rest on the points of the prisms. The two prisms have their sides ground and move with considerable friction on each other. A set-screw through the top of the cubical box clamps the top prism upon the bottom prism, and the latter against the bottom of the box.

In the figure B is the adjusting-screw, A is the pivot-end, P is one prism, CC is the circle-limb, and D is the back of

the box. The V-shaped spring has the point of the V against the middle of D, and one leg rests on *a*.

To use the adjusting-screws on the outside, you must loosen the set screw; the prisms will now slide upon each other, but not freely, since their adjacent surfaces are ground. A movement of the adjusting-screw is opposed by the very unsatisfactory spring. Withdrawing the screw *should* produce a motion of the prism, but usually does not. Suppose that one prism A is adjusted and the other B is out. The process of adjusting B is this. The set-screw is loosened. The adjusting-screw of B is moved a little way. If the motion of B is in the right direction then one is fortunate and goes on. One observer must watch A, while the other adjusts B and watches it. Usually A is moved from the cor-




rect reading before B arrives at it. Then the adjusting-screw of A must be touched, and so on. Finally, clamping the set screw destroys the accuracy of *both* adjustments; which have to be so made that a clamping of this screw will complete them — an uncertain task. These are real defects. Add to this that the slightest over pressure on the screws chips the delicate edge of the prisms, as I found to my cost.

In any event the edges of the prisms should be protected by a small shoe of sheet brass; the two prisms should be

separated by a thin diaphragm of sheet brass fixed to the sides of the cubical box; and each should have its own set screw. If this is not done, then every circle should have an extra setting microscope to be used in case the regular one is out of order, as it is sure to be at sometime.

In our circle, I have had a small brass shoe put on the edge of the prism at the point where the adjusting screw presses. The tin foils at the pivot ends have been replaced by brass plates of the same thickness as the shoes. The north eye-piece of the setting microscope (circle east) has been replaced by a cheap filar micrometer with one moveable wire. We can now adjust the setting-microscope readily as follows: First, prism A is moved until the image of the required circle division falls on the fixed wire of eye-piece A; and then the movable wire of eye-piece B is placed on the image of the same circle-division, whenever it may happen to fall in the field of view. Finally, the single spider lines of the two eye-pieces have been replaced by thin plates of mica, whose blackened edges make a much better fiducial line than the faint spider thread. The setting microscope, with these changes, leaves nothing to be desired.

### STEPS FOR READING THE MICROSCOPES.

At my request the Messrs. REPSOLD sent me the drawings of steps for reading the microscopes. It is not necessary to give the dimensions here, but I wish to say that these are very convenient, both for reading all four microscopes, or for zone observations, where only one microscope is read.

I have carpeted the steps and seat throughout. This makes the footing more sure, and absorbs the dust instead of allowing it to get upon the circle.

### ARTIFICIAL HORIZON.

This is excellently and conveniently made on the plan described by BESSEL, in *Abhandlungen*, vol. ii, page 63.

All draughts and dampness from beneath the floor are completely avoided by this means. We use a joint of common tin furnace pipe (12 inches in diameter), over the basin during Nadir observations to keep off draughts from above the floor.

### ILLUMINATING LAMPS.

Two excellent Argand lamps in convenient tin cases were provided by the REPSOLDS. I have mounted them nine feet ten inches from the center of the cube. I have also provided two gas burners which can be exchanged for the lamps in about one minute. Over each lamp, and also over a free gas burner for illuminating the room, I have put a 3-inch rain conductor which goes through the ceiling, and which delivers the heat from the lamps out of doors (not through the slit.) These tubes end just above the lamps in inverted funnels, 12 inches in diameter.

### VENTILATION OF ROOM.

The air space above the flat ceiling of the meridian room is covered on the sides of the slit by wire netting, so as to allow of a free circulation of air, and it communicates with the external air when the shutters are closed, by 43 holes each three inches in diameter, which I have put in the cornice. The temperature of the room and of the air space is kept the same by this simple means. Before it was adopted the air space was extremely hot in summer days. The following table will exhibit the improvement.

| Date 1883. | Time. | External thermometer. | Thermometer just above the circle. | Thermometer in air space. | Remarks. |
|---|---|---|---|---|---|
| August 7 | $22^h\ 30^m$ | 70°.5 | 71°.0 | 72°.0 | Slit opened at 22h 20m. |
| 16 | 3 0 | 77 .5 | 74 .0 | 80 .0 | |
| 18 | 3 0 | 81 .0 | 82 .0 | 84 .0 | |
| 28 | 3 50 | 67 .0 | 72 .0 | | |
| Sept. 1 | 0 30 | 76 .0 | 77 .8 | 78 .5 | Room entirely closed. |
| 15 | 2 50 | 79 .5 | 76 .4 | 81 .0 | |
| 19 | 22 10 | 60 .5 | 62 .8 | 65 .5 | Room opened at 20h 45m |
| 27 | 3 0 | 61 .0 | 62 .0 | 63 .8 | |
| Oct. 18 | 3 40 | 61 .0 | 62 .8 | 64 .0 | |

It appears that the difference of temperature between the air-space and the room, which was formerly 10°—15° in hot weather, has been reduced to 4° or so, by the simple device of boring the 3-inch holes.

REMARKS ON THE USES TO WHICH THIS CIRCLE IS FITTED.

A meridian circle of this class is especially fitted for doing fundamental work. The telescope is large enough to show 9th magnitude stars in a bright field, and the whole design of the circle is of the very best. For such work the whole circle must be investigated thoroughly; and it is especially important that frequent recourse should be had to nadir observations. In fact, we now have a model of the way in which fundamental observations with a meridian circle should be conducted in the volumes of the LEYDEN observations.

A very important research of this nature which seems to be obligatory upon every astronomer who possesses a first-class meridian circle is a thorough determination of his latitude. A list of stars selected from AUWERS' Fundamental Catalogue is now under observation here for this purpose.

The meridian circle of the Washburn Observatory is somewhat unfortunately situated as regards work in the northern regions of the sky. The site of the house is the nearly level top of a hill. To the west and east the ground slopes gently. To the south it is about level for some thirty feet, and then it descends about 40 feet in going southwards about 300 feet. After this plane is reached, the ground is nearly level for about eight miles, when a range of hills is reached, which are somewhat higher than the observatory hill.

The contour of the site towards the south makes it well nigh impossible to establish a (near) meridian mark. Towards the north along the meridian the ground slopes at first gradually and then rapidly to Lake Mendota; 100 feet north of the meridian circle the surface of the ground is 17 feet below the floor; and it slopes very quickly from this point as the following table will show:

| Feet north of piers..... | 100 | 200 | 300 | 400 | 500 | 600 | 700 |
|---|---|---|---|---|---|---|---|
| Surface below floor..... | 17 | 30 | 47 | 62 | 77 | 90 | 107 |

At 700 feet horizontal from the piers the shore of Lake Mendota is reached, and then we have towards the north a

level sheet of water about four miles wide. The opposite shore is a bluff some 50 feet high.

Stars culminating north of the Zenith must then be observed through air which lies over the lake, while stars south of the Zenith are observed through air which lies over land. The refraction for low circumpolars and for extreme south stars may be different. The lake is usually frozen from about December 5 to April 15 of each year, and the surface is covered with snow from three inches to three feet deep. During this period then, the relations of the surface of the ground to the superincumbent air are the same north and south, and *a priori* this season would seem to be the period for the accurate determination of the latitude. In the summer, it is possible that it will be necessary to determine two different co-efficients of refraction. One will serve for observations of north stars and the other for south stars. A list of refraction-stars is now under observation. Provided that the nadir can be continuously observed, it would seem that by suitably choosing the seasons of observation, fundamental work is practicable. Observations of the sun, however, would require a very careful treatment, since the winter and summer conditions are so different.

Unless strictly fundamental work is to be done it appears to be proper to do strictly differential work. The present admirable star list of the *Berliner Jahrbuch* makes this easy and accurate. For the present at least, all observations will be referred to the system of the B. J. in both co-ordinates. Those values of the flexure, of the refraction and of the latitude which best represent the normal system will be adopted and consistently used.

Investigations of the flexure, of the corrections to the Pulkova refractions to fit them to our conditions, and to the assumed latitude are now in progress. A list of miscellaneous stars for observation has also been selected.

### VIBRATIONS OF THE SOIL.

From the pains taken with the piers I had hoped to find their stability perfect; and so far as the piers themselves are concerned I have every reason to be satisfied with them. I

have found, however, that the piers and foundations together are extraordinarily sensitive to vibrations in the surrounding ground, which is composed of fine building sand. I tested this thoroughly January 11, 1883, by having an assistant produce shocks in various places and by noticing the effects of these on the regular mercurial horizon, or on boxes of mercury placed on the piers of the instrument and collimators.

A person walking about on the floor of the transit room will just produce a slight tremor in the horizon. A strong blow with the foot anywhere on the floor of the room or of the adjacent hall will show itself in the mercury by a quick tremor. I satisfied myself in the most positive way Jan. 12 that such shocks were *not* communicated through the floor and to the wooden cases of the piers and thus to the horizon, but that they were transmitted downwards through the floor beams and to the brick supporting walls and thence through the fine, dry and unfrozen sand to the piers and to the horizon. Finally I had an assistant strike the ground with the end of a heavy 4x4 timber some 7 feet long, and such shocks were manifest in the mercury even when the blow was given fifty feet away from the piers and quite outside of the building. It was transmitted through the frozen sand. Such a shock fifty feet outside of the buildings seemed to be nearly as perceptible as one made within two or three feet of the walls.

On several occasions when I had the level (1 div. = 1.″2) suspended from the telescope for the purpose of determining the value of a division (not resting on the pivots) the bubble has suddenly begun to move north and south with an approximately periodic motion. The swings have occupied from $^{s}$ to $1^{m}\ 30^{s}$ for a half oscillation and the amplitude has ranged from 0″ to 13.″ I attribute this to the movements communicated to the hill by the ice in the adjacent lake, which is here four miles wide.

As far as I can determine these effects are very transitory and the result on the observations will be that the accidental errors will be increased perhaps largely. I do not now see

that any serious sources of constant error exist in this direction.

I add the instructions sent by the REPSOLDS to us:

"REMARKS RELATING TO THE PLACING OF THE MERIDIAN-CIRCLE.

"After the iron pier-heads are placed upon the piers, (of which a drawing has been furnished) all the correction-screws are to be put in the middle of their play; and then the base plates, with the pier-heads (microscope-bearers) are to be placed approximately in their correct position, without the use of the screws.

To help in this process there is packed in one of the boxes a wooden axis whose length and the dimensions of whose ends correspond with those of the axis of the instrument. By placing this wooden axis in the pivots, and by applying the hanging-level, it is easy to assure oneself of the correct level of the pier-heads, and of their proper distance apart. This distance must be the same as that of the feet of the level. If a diopter (or what is the same thing — a small telescope, provided with cross hairs) is fastened on to the middle of the wooden axis, it will be easy to see by means of a distant meridian mark, whether the axis is sufficiently near to the meridian. Also, the small arm, which is fastened to the end of the wooden axis will show whether the faces of the microscope bearers are placed parallel to the meridian. This can be tested by rotating the wooden axis in the pivots.

After these preliminary corrections are made, the base-plates can be fixed to the tops of the (brick) piers, with cement, or with plaster of Paris: and in the same way the large screws which fit into the cylindrical holes in the tops of the piers, can be fastened. The reversing-carriage is already adjusted to receive the axis, as soon as the large screw is inserted, and as soon as the movable bearer is fixed to this. The wooden stand must not be taken to pieces; it is only necessary to unscrew the iron tube with the worm-nut, and the large bevel-gear from the spindle, and to again screw both these parts together after the spindle is passed through the upper bearing. Before the rails (for the reversing-carriage) are fastened to the floor, the spindle must be placed vertical, by means of a try-level, fastened to the movable arm of the spindle, and at the same time the spindle is to be placed midway between the microscope-bearers. Then, the places of the rails can be marked down on the floor. After this the axis of the instrument (just as it is in the boxes) can be placed on the reversing carriage, for the purpose of fitting the circles, the object-glass, the ocular, etc. As soon as the large levers, which hold the hooks which take hold of the axis, are fitted with the counter poises, and with the hooks themselves, the axis can be placed in the Ys. At this place one must be sure that only one of the small levers which serve as end-supports of the axis, has its adjusting-screw set up, while the clamp on the screw of the other lever is left open, so that the inner pin of the screw may slide freely, and so that the lever can only be pushed forward by the motion of its thread. Otherwise, the axis will, as it moves on the wedge-shaped ends or the lever, have the

effect of bringing the tops of the piers nearer together. Moreover, one must observe whether the axis lifts perpendicular to the Y's, when the counter-weights are slightly over weighted: whether it touches only on one side of the Y's: and again, whether its ends are at unequal distances from the faces of the microscope-bearers. This last may be caused by the end-levers holding on too long. The first error may be corrected, when necessary, by turning slightly the four adjusting screws of the fulcrums of the levers of the counter-weights. For correction of the other faults, it may be necessary to ream out new bearings in the large lever (of the counter-weights) for the bearing-screws of the hooks which hold up the axis.

Care must also be taken that the slow motion in declination, after it is fastened to one of the movable iron arms, which are fixed to the two base-plates, is so fastened that the under movable part of the declination-arm comes in the middle of the screw that bears against the end. Under the hooks of the counter-weight are two eyes, into which the hooks at the ends of the two chains are to be slipped, whenever the instrument is to be reversed. The other ends of these chains are to be fixed to the wooden casings of the pier, and also the fair-leaders, which hold the upper parts of the chains nearly vertical. If the chains are made of the right length, they will hold on to the bar of the hooks, as soon as the axis is slightly lifted, and the pier will then always be charged with the same load.

The artificial horizon is to have its foundation so arranged on the base of the pier, that the under end of the ring, which is to be fixed in the floor, and which takes the cover, may enter the channel of the foundation, without touching it. By putting a little oil, or mercury, in this channel, the currents of air will be excluded, without the transmission of shocks from the floor to the piers. The two lamps are to be placed in the prolongation of the axis, at a distance of about two metres from the middle of the instrument. The wooden axis is hollow, in order to admit of their easy adjustment. Place this axis in the Ys, and place the lamps so that they shine through the axis. This is to be done without the two lenses and with the lamp doors wide open. The lenses are to be placed in such a position that they concentrate their beams upon the four mirrors. If the objective and ocular are interchanged, no change need be made in the illumination. The key which lies next to the telescope tube, changes the illumination from bright field to dark; the other changes the intensity of either mode."

## TABLES OF THE INSTRUMENTAL CONSTANTS FROM JULY 8, TO DECEMBER 31, 1883.

The instrumental constants of the Circle and Collimators have been determined very frequently during the period, July 8th — December 31st, for the purpose of studying the Circle and piers. The observations have generally been made by Mr. TATLOCK. They have been projected into

curves and the study of these curves has led to our programme for the determination of the various constants and for the conduct of the observations. The curves are not given here, but the tables of constants are as follows:

## TABLE I.

RECORD OF CONSTANTS, *a; b; c; n.*

| DATE. | Time. | *a.* | *b.* nadir. | *b.* level. | *c.* | Remarks. |
|---|---|---|---|---|---|---|
| 1883. | h m | s | s | s | s | |
| July 8 | 20–10 | | −0.455 | −0.368 | +0.013 | The values marked |
| *8 | ..... | +4.347 | −0.343 | −0.353 | +0.077 | with a star were de- |
| 9 | 20–20 | ..... | −0.528 | −0.447 | +0.039 | termined by G. C. C. |
| 10 | 21– 0 | ..... | −0.523 | −0.495 | +0.064 | The epoch of his de- |
| 11 | 20–30 | ..... | −0.442 | −0.484 | +0.116 | termination is uni- |
| *11 | ..... | +4.51 | −0.530 | −0.553 | +0.103 | formly about 8h 30m. |
| 12 | 20–30 | ..... | −0.429 | −0.360 | +0.034 | |
| 13 | 20–30 | ..... | −0.485 | −0.436 | +0.077 | |
| 14 | 21– 0 | ..... | −0.446 | −0.380† | +0.047 | † *b* level determined |
| *14 | ..... | +4.42 | −0.444 | −0.462 | +0.086 | 19h 30m. |
| 15 | 21– 0 | ..... | −0.519 | −0.502 | +0.069 | |
| 16 | 7–10 | ..... | −0.553 | −0.493 | +0.064 | |
| 16 | 20–45 | ..... | −0.498 | −0.442 | +0.039 | |
| 17 | 20–30 | ..... | −0.463 | −0.455 | +0.086 | |
| *17 | ..... | +4.27 | −0.445 | −0.489 | +0.084 | |
| 18 | 20–30 | ..... | −0.485 | −0.517 | +0.099 | |
| 19 | 20–30 | ..... | −0.549 | −0.560 | +0.099 | |
| 20 | 21– 0 | ..... | −0.588 | −0.596 | +0.116 | |
| 21 | 20–15 | ..... | −0.639 | −0.665† | +0.111 | †*b* level determined |
| *21 | ..... | +4.64 | −0.636 | −0.650 | +0.098 | 19h 30m. |
| 22 | 20–30 | ..... | −0.493 | −0.480 | +0.120 | |
| 23 | 20–45 | ..... | −0.403 | −0.397 | +0.116 | |
| 24 | 20–45 | ..... | −0.407 | −0.401 | +0.107 | |
| *24 | ..... | +4.60 | −0.345 | −0.395 | +0.129 | |
| 25 | 20–30 | +4.595 | −0.506 | −0.495 | +0.111 | Epoch of $a$=8h 30m. |
| 26 | 21–15 | ..... | −0.360 | −0.383 | +0.107 | |
| 27 | 21–30 | +4.500 | −0.339 | −0.333 | +0.098 | Epoch of $a$=8h 30 . |
| 28 | 21–40 | ..... | −0.335 | −0.365 | +0.120 | |
| 29 | 21–10 | ..... | −0.360 | −0.368 | +0.107 | |
| 30 | 20–50 | +4.563 | −0.386 | −0.395 | +0.116 | |
| 31 | 20–30 | +4.570 | −0.429 | −0.435 | +0.103 | Epoch of $a$=8h 20m. |
| Aug. 1 | 22– 0 | ..... | −0.385 | −0.328 | +0.120 | |
| 3 | 4–30 | +4.357 | −0.345 | −0.319 | +0.086 | Epoch of $a$=8h 10m. |
| 4 | 2–45 | ..... | −0.352 | −0.364 | +0.120 | |
| 5 | 3–15 | ..... | −0.347 | −0.326 | +0.090 | |
| | 3–15 | ..... | −0.326 | −0.296 | +0.116 | |
| | 7–30 | +4.367 | −0.283 | −0.330 | +0.120 | Epoch of $a$=8h 30m. |
| 7 | 2–40 | ..... | −0.326 | −0.313 | +0.103 | |
| 8 | 3– 0 | ..... | −0.356 | −0.351 | +0.086 | |
| 9 | 3– 0 | +4.344 | −0.313 | −0.307 | +0.082 | Epoch of $a$=8h 45m. |
| 9 | 8–30 | ..... | ..... | −0.333 | ..... | |
| 10 | 4– 0 | ..... | −0.360 | −0.264 | +0.099 | |
| 11 | 3–30 | ..... | −0.395 | −0.433 | +0.107 | |
| 12 | 3–20 | ..... | −0.352 | −0.357 | +0.086 | |
| 13 | 3–30 | +4.285 | −0.244 | −0.230 | +0.103 | Epoch of $a$=8h 30 . |
| 13 | 8–30 | ..... | ..... | −0.223 | ..... | |

TABLE I — *Record of Constants* — continued.

| DATE. | TIME. | *a.* | *b.* nadir. | *b.* level. | *c.* | REMARKS. |
|---|---|---|---|---|---|---|
| 1883. | h. m. | | s. | s. | s. | |
| Aug. 14 | 3–30 | ..... | —0.249 | —0.274 | +0.090 | |
| 15 | 3–30 | ..... | —0.244 | —0.261 | +0.099 | |
| 16 | 3–30 | ..... | —0.335 | —0.341 | +0.090 | |
| 17 | 3–30 | ..... | —0.390 | —0.482 | +0.094 | |
| 18 | 3–30 | +4.504 | —0.450 | —0.472 | +0.094 | Epoch of a = 8h. 0m. |
| 19 | 3–15 | ..... | —0.459 | —0.467 | +0.090 | Higher power eye-piece put in collimator X to-day. |
| 20 | 3–20 | +4.340 | —0.181 | —0.236 | [+0.030] | Evidently erroneous setting of same. |
| 21 | 3–15 | ..... | ..... | —0.312 | ..... | |
| 21 | 7–15 | +4.458 | —0.322 | —0.295 | +0.073 | Epoch of a = 7h. 50m. |
| | | | at 7h. 15m. | | | |
| 22 | 3–0 | ..... | —0 073 | —0.220 | +0.094 | Azimuth adjusted at 5h. |
| | 3–30 | ..... | ..... | —0.100 | ..... | |
| 23 | 7–30 | +0.033 | —0.086 | —0.076 | +0.067 | |
| 24 | 3–10 | ..... | —0.073 | —0.092 | +0.082 | *b* (nadir) at 7h. 20m. |
| 25 | 4–15 | ..... | —0.112 | —0.071 | +0.069 | *b* (nadir) at 7h. 10m. |
| 26 | 4–0 | +0.100 | —0.086 | —0.085 | +0.060 | Epoch of a = 7h. 45m. |
| *26 | 8–0 | ..... | ..... | —0.058 | ..... | |
| 27 | 3–0 | ..... | —0.086 | —0.065 | +0.069 | |
| 28 | 3–30 | +0.135 | —0.159 | —0.159 | +0.060 | Epoch of a = 8h. 15m. |
| 29 | 7–30 | ..... | —0.137 | —0.134 | +0.065 | |
| 30 | 3–45 | +0.044 | —0.137 | —0.156 | +0.069 | Epoch of a = 7h. 15m. |
| *30 | 7–30 | ..... | ..... | —0.149 | ..... | |
| 31 | 4–0 | ..... | —0.287 | —0.234 | +0.064 | |
| Sept. 1 | 4–0 | +0.050 | —0.240 | —0.218 | ..... | Epoch of a = 8h. 15m. |
| *1 | 9–0 | ..... | ..... | —0.208 | ..... | |
| 2 | 3–0 | ..... | —0.209 | —0.211 | ..... | |
| 3 | 3–30 | —0.106 | —0.116 | —0.114 | +0.069 | Epoch of a = 8h. 15m. |
| 4 | 3–30 | ..... | —0.060 | —0.075 | ..... | |
| 5 | 3–30 | ..... | —0.039 | —0.045 | ..... | |
| 6 | 3–0 | ..... | —0.107 | —0.122 | ..... | Changed focus of the telescope slightly. |
| 7 | 3–0 | ..... | ..... | —0.106 | ..... | |
| *8 | 8–0 | ..... | ..... | —0.055 | ..... | |
| 8 | 3–30 | —0.342 | ..... | +0.007 | +0.064 | Epoch of a = 8h. 15m. |
| 9 | 7–30 | ..... | —0.103 | —0.149 | ..... | |
| 10 | 7–30 | ..... | .. .... | —0.118 | ..... | |
| 10 | 3–15 | —0.288 | ..... | —0.116 | ..... | Epoch of a = 8h. 0m. |
| *11 | 7–30 | ..... | ..... | —0.145 | ..... | |
| 11 | 5–0 | —0.249 | —0.137 | —0.146 | ..... | Epoch of a = 8h. 0m. |
| 12 | 5–0 | ..... | —0.159 | —0.183 | ..... | |
| 13 | 3–30 | ..... | ..... | —0.145 | ..... | Focus changed at 6h. |
| *14 | 11–40 | ..... | .. .... | —0.208 | ..... | Focus changed at 10h. |
| 14 | 3–15 | —0.085 | ..... | —0.212 | ..... | Epoch of a = 11h 30m. |
| 15 | 3–15 | ... .... | —0.279 | —0.302 | ..... | At 10h changed setting of objective in its cell and adjusted focus. |
| 16 | 3–0 | ..... | ..... | —0.226 | ..... | |
| 17 | 7–15 | ..... | ..... | —0.048 | ..... | Adjusted. |
| 17 | 3–30 | —0.242 | —0.086 | —0.117 | +0.047 | Epoch of a = 7h. 50m. |
| 17 | 23–30 | ..... | ..... | —0.086 | ... ... | |
| 18 | 0–10 | ..... | ..... | —0.089 | +0.047 | |
| 18 | 8–0 | ..... | —0.043 | —0.028 | ..... | Removed eye-end from tube for space of 5 minutes. |
| *18 | 0–30 | ..... | ..... | ..... | ..... | |

TABLE I — *Record of Constants* — continued.

| Date. | Time. | a. | b. nadir. | b. level. | c. | n. | REMARKS. |
|---|---|---|---|---|---|---|---|
| 1883 | h. m. | s | s | s | s | s | |
| Sept. 19 | 3- 0 | ..... | —0.094 | —0.067 | ..... | ..... | Allowed sun |
| 20 | 3- 0 | ..... | ..... | —0.095 | ..... | ..... | to shine on in- |
| 21 | 8- 0 | ..... | ..... | —0.112 | ..... | ..... | strument 2m. |
| 21 | 3- 0 | —0.454 | ..... | —0.106 | ..... | ..... | 40s.; no effect |
| 22 | 4- 0 | ..... | ..... | —0.139 | ..... | ..... | on any of the |
| 23 | 5- 0 | ..... | ..... | —0.185 | ..... | ..... | constants. |
| 24 | 4-30 | ..... | —0.270 | —0.168 | —0.006 | ..... | |
| 25 | 2- 0 | —0.473 | —0.206 | —0.105 | ..... | ..... | |
| 25 | 8-15 | ..... | ..... | —0.147 | ..... | ..... | |
| 26 | 5-30 | ..... | —0.107 | —0.142 | +0.099 | ..... | Epoch of a= |
| 27 | 5- 0 | —0.327 | —0.123 | —0.129 | ..... | +0.150 | 2h. 0m. |
| 30 | 8- 0 | —0.584 | ..... | —0.187 | ..... | ..... | Epoch of n= |
| Oct. 1 | 9- 0 | ..... | ..... | —0.209 | +0.146 | ..... | 7h. 30m. |
| 2 | 5- 0 | —0.585 | —0.215 | —0.188 | +0.112 | ..... | |
| 3 | 6-50 | ..... | —0.210 | ..... | ..... | ..... | |
| 7 | 7-30 | —0.420 | ..... | —0.276 | ..... | ..... | |
| 8 | 3- 0 | ..... | ..... | ..... | +0.090 | ..... | |
| 10 | 5-10 | ..... | ..... | —0.277 | ..... | ..... | |
| 10 | 6-50 | —0.352 | ..... | —0.261 | ..... | +0.097 | |
| 15 | 3-45 | ..... | ..... | —0.191 | ..... | ..... | |
| 15 | 6-40 | —0.761 | ..... | —0.181 | ..... | +0.429 | |
| 16 | 7- 0 | —0.781 | ..... | —0.213 | +0.090 | +0.425 | |
| 18 | 3-30 | ..... | ..... | —0.287 | ..... | ..... | |
| 18 | 8-40 | —0.655 | ..... | —0.344 | ..... | ..... | |
| 23 | 3-30 | ..... | ..... | —0.246 | +0.082 | ..... | |
| 23 | 8-40 | —0.926 | ..... | —0.241 | ..... | ..... | |
| 25 | 8- 0 | —0.725 | ..... | —0.296 | ..... | ..... | |
| 29 | 4- 0 | ..... | ..... | —0.412 | +0.073 | ..... | |
| 29 | 10- 0 | —0.559 | ..... | —0.417 | ..... | ..... | |
| 31 | 4- 0 | ..... | ..... | —0.334 | ..... | ..... | |
| 31 | 7-40 | —0.921 | ..... | ..... | ..... | +0.445 | |
| Nov. 1 | 4- 0 | ..... | ..... | —0.245 | ..... | ..... | |
| 1 | 10-40 | —1.072 | ..... | —0.278 | ..... | +0.605 | |
| 2 | 5- 0 | ..... | ..... | —0.333 | ..... | ..... | |
| 2 | 10-30 | —0.977 | ..... | —0.387 | ..... | +0.459 | |
| 3 | 5- 0 | ..... | ..... | —0.408 | ..... | ..... | |
| 4 | 4-50 | ..... | ..... | —0.426 | ..... | ..... | |
| 4 | 21-30 | ..... | ..... | ..... | +0.047 | ..... | |
| 5 | 5-10 | ..... | ..... | —0.531 | ..... | ..... | Epoch of n= |
| 6 | 4-40 | —0.948 | ..... | —0.375 | ..... | +0.436 | 6h 15m. |
| 7 | 4-40 | ..... | ..... | —0.313 | ..... | ..... | |
| 8 | 4- 0 | ..... | ..... | —0.321 | ..... | ..... | |
| 8 | 7-30 | —0.893 | ..... | —0.358 | ..... | ..... | |
| 9 | 5-30 | ..... | ..... | —0.382 | ..... | ..... | |
| 10 | 4- 0 | ..... | ..... | —0.393 | ..... | ..... | |
| 10 | 9- 0 | —0.761 | ..... | —0.348 | ..... | +0.317 | |
| 11 | 4- 0 | ..... | ..... | —0.279 | ..... | ..... | |
| 12 | 4- 0 | ..... | ..... | —0.054 | +0.073 | ..... | |
| 13 | 5- 0 | ..... | ..... | —0.214 | ..... | ..... | |
| 13 | 8-30 | —1.704 | ..... | —0.287 | ..... | ..... | |
| 14 | 4-15 | ..... | ..... | —0.110 | ..... | ..... | |
| 15 | 4- 0 | ..... | ..... | —0.301 | ..... | ..... | |
| 15 | 7-15 | —1.691 | ..... | —0.307 | ..... | ..... | |
| 16 | 7-30 | ..... | ..... | —0.190 | ..... | ..... | |
| 17 | 0- 0 | ..... | ..... | —0.312 | ..... | ..... | |
| 17 | 9- 0 | —1.390 | ..... | —0.378 | ..... | +0.763 | |
| 18 | 4- 0 | ..... | ..... | —0.429 | ..... | ..... | |

TABLE I.— *Record of Constants* — continued.

| Date. | Time. | *a*. | *b* level. | *c*. | *n*. | Remarks. |
|---|---|---|---|---|---|---|
| 1883. | h m | s | s | s | s | |
| Nov. 19 | 4- 0 | ..... | —0.467 | ..... | ..... | |
| 19 | 6- 0 | —1.121 | —0.509 | ..... | ..... | |
| 20 | 8- 0 | ..... | —0.509 | +0.090 | .... ... | |
| 21 | 4-45 | ..... | —0.391 | ..... | ..... | |
| 22 | 4-45 | ..... | —0.355 | ..... | ..... | |
| 22 | 21-31 | ..... | ..... | +0.060 | ..... | |
| 23 | 4-30 | ..... | —0.391 | ..... | ..... | |
| 24 | 0- 0 | ..... | —0.472 | ..... | ..... | |
| 24 | 5-30 | —0.892 | —0.414 | ..... | ..... | |
| 25 | 4-15 | ..... | —0.551 | ..... | ..... | |
| 26 | 5- 0 | ..... | —0.251 | +0.004 | ..... | |
| 27 | 4-30 | —1.213 | —0.308 | ..... | ..... | |
| 28 | 4- 0 | ..... | —0.386 | ..... | ..... | |
| 29 | 1- 0 | ..... | —0.305 | ..... | ..... | |
| 30 | 4-15 | ..... | —0.470 | ..... | ..... | |
| Dec. 1 | 4-15 | —1.059 | —0.574 | ..... | ..... | |
| 2 | 2- 0 | ..... | —0.474 | ..... | ... .... | |
| 3 | 4-15 | ..... | —0.450 | +0.004 | ..... | |
| 4 | 4-30 | —1.310 | —0.457 | ..... | ..... | |
| 5 | 4-30 | ..... | —0.561 | ..... | ..... | |
| 8 | 4-30 | —1.070 | —0.335 | ..... | ..... | |
| 11 | 5-15 | ..... | —0.516 | ..... | ..... | |
| 11 | 4-30 | —1.058 | —0.483 | —0.013 | ..... | |
| 14 | 6-40 | ..... | —0.520 | ..... | +0.676 | |
| 18 | 9- 0 | —2.370 | +0.042 | —0.047 | ..... | |
| 20 | 9- 0 | —1.762 | +0.134 | ..... | ..... | |
| 24 | 7-20 | ..... | —0.672 | ..... | ..... | |
| 24 | 9- 0 | —0.687 | —0.682 | —0.069 | ..... | |
| 27 | 8- 0 | ..... | —0.446 | ..... | ..... | |
| 27 | 9- 0 | —0.976 | —0.411 | ..... | ..... | |
| 31 | 3-30 | ..... | —0.685 | —0.064 | ..... | |

# TABLE II.

## RECORD OF COLLIMATOR LEVELS.

| DATE. | Time. | Circle | Correction. N. C. X. 1396. | Correction. N. C. X. 1399. | Correction. S. C. Y. 1396. | Correction. S. C. Y. 1399. | REMARKS. |
|---|---|---|---|---|---|---|---|
| 1883. | h. m. | | " | " | " | " | |
| July 9 | 22- 0 | W. | —4.46 | ..... | ..... | +6.29 | N. C. = North |
| 10 | 22- 0 | W. | —4.59 | ..... | ..... | +6.73 | Collimator. |
| 11 | 22-30 | W. | —4.12 | ..... | ..... | +6.56 | S. C. = South |
| 12 | 22-15 | W. | —3.92 | ..... | ..... | +5.81 | Collimator. |
| 13 | 21-45 | W. | —4.10 | ..... | ... .... | +7.00 | X and Y are the |
| 14 | 19-30 | W. | —5.90 | ..... | ..... | +6.55 | two collima- |
| 15 | 22-10 | W. | —5.76 | ..... | ..... | +6.49 | tors. |
| 16 | 21-40 | W. | —6.81 | ..... | ..... | +6.61 | |
| 17 | 21-50 | W. | —7.81 | ..... | ..... | +6.84 | |
| 18 | 22- 0 | W. | —6.68 | ..... | ..... | +6.55 | |
| 19 | 21-45 | W. | —6.54 | ..... | ... .... | +6.24 | |
| 20 | 22-30 | W. | —5.97 | ..... | ..... | +6.86 | |
| 21 | 19-30 | W. | —5.74 | ..... | ..... | +7.70 | |
| 22 | 20-40 | W. | —5.78 | ..... | ..... | +6.16 | |
| 23 | 20-50 | W. | —5.82 | ..... | ..... | +6.54 | |
| 24 | 21- 0 | W. | —5.95 | —6.45 | +5.89 | +5.93 | |
| 25 | 21-15 | W. | —5.50 | —5.94 | +5.56 | +6.25 | |
| 26 | 2- 0 | W. | —6.46 | —6.50 | +6.64 | +7.28 | |
| 26 | 3- 0 | W. | ..... | ..... | +6.48 | +7.08 | |
| 26 | 22-30 | W. | —6.26 | —6.58 | +6.15 | +6.63 | |
| 27 | 22-50 | W. | —7.13 | —7.22 | +4.81 | +5.42 | |
| 29 | 2-15 | W. | —7.82 | —7.82 | +3.70 | +4.93 | |
| 29 | 23-30 | W. | —7.24 | —8.08 | +3.64 | +4.54 | |
| 30 | 22-40 | W. | —7.43 | —7.60 | +3.65 | +4.26 | |
| 31 | 22- 0 | W. | —7.16 | —7.44 | +4.18 | +4.70 | |
| Aug. 1 | 23-20 | W. | —6.20 | —6.93 | +3.75 | +3.68 | |
| 3 | 5-35 | W. | —7.70 | —8.31 | +3.61 | +4.02 | |
| 4 | 3-20 | W. | —7.74 | —8.13 | +3.12 | +3.23 | |
| 5 | 4-40 | W. | —8.14 | —8.71 | +3.35 | +3.83 | |
| 6 | 4-20 | W. | —7.02 | —7.54 | +2.90 | +2.91 | |
| 7 | 4- 0 | W. | —7.80 | —8.57 | +3.88 | +3.92 | |
| 8 | 4-30 | W. | —8.33 | —8.48 | +4.30 | +4.13 | |
| 9 | 4-15 | W. | —8.57 | —9.25 | +4.08 | +4.51 | |
| 10 | 5- 0 | W. | —8.57 | —8.99 | +4.00 | +4.34 | |
| 11 | 5-10 | W. | —8.24 | —8.73 | +4.31 | +4.57 | Rain. |
| 12 | 4-15 | W. | —7.28 | —6.95 | +4.32 | +4.67 | |
| 13 | 4-30 | W. | —8.59 | —9.59 | +3.84 | +4.36 | |
| 14 | 4-15 | W. | —8.28 | —8.84 | +4.14 | +4.02 | |
| 15 | 4- 0 | W. | —8.13 | —9.21 | +2.21 | +2.36 | |
| 16 | 4- 0 | W. | —7.26 | —8.57 | +2.53 | +2.23 | |
| 17 | 4- 0 | W. | —7.21 | —8.93 | +3.15 | +3.32 | Rain, small |
| 18 | 3-45 | W. | —7.83 | —8.34 | +2.91 | +2.97 | amount. |
| 19 | 3-30 | W. | —7.64 | —8.73 | +3.69 | +4.02 | Rain, only a |
| 20 | 3-45 | W. | —8.10 | —7.86 | +2.36 | +1.73 | shower. |
| 21 | 3-40 | W. | —8.13 | —9.63 | +2.15 | +3.54 | |
| 22 | 4- 0 | W. | —8.18 | —9.26 | +3.21 | +2.51 | |
| 23 | 4- 0 | W. | —9.87 | -10.29 | —0.17 | +0.83 | 3h. 30m. N. C. |
| 24 | 3-45 | W. | ..... | ... .... | +1.51 | +1.13 | adjusted. |
| 25 | 5- 0 | W. | —1.43 | —1.12 | +1.61 | +1.44 | |

TABLE II.— *Record of Collimator Levels* —continued.

| Date. | Time. | Circle. | N. C. X. 1396 | S. C. Y. 1396 | Date. | Time. | Circle. | N. C. X. 1396 | S. C. Y. 1396 |
|---|---|---|---|---|---|---|---|---|---|
| 1883 | h. m. | | | | 1882 | h. m. | | | |
| Aug. 26 | 3–30 | W. | —1.″42 | +0.″83 | Sept. 30 | 5–15 | W. | —4.98 | +4.81 |
| 27 | 3–45 | W. | —0.63 | +0.45 | Nov. 1 | 4–30 | W. | —3.16 | +3.74 |
| 28 | 5–0 | W. | —0.50 | +3.20 | 2 | 5–15 | W. | —3.56 | +3.93 |
| 29 | 4–45 | W. | —0.09 | +2.68 | 3 | 5–30 | W. | —2.73 | +4.81 |
| 35 | 3–30 | W. | —1.07 | +3.12 | 4 | 4–00 | W. | —2.10 | +4.46 |
| 31 | 5–20 | W. | —0.71 | +3.01 | 5 | 5–10 | W. | —1.67 | +4.59 |
| Sept. 1 | 4– 0 | W. | —0.24 | +3.75 | 6 | 5– 0 | W. | —1.84 | +4.88 |
| 2 | 3– 0 | W. | +0.01 | +2.12 | 7 | 5– 0 | W. | —2.13 | +6.00 |
| 3 | 3–30 | W. | +0.01 | +3.03 | 8 | 5– 0 | W. | —1.57 | +6.01 |
| 4 | 3–15 | W. | +1.48 | +0.75 | 9 | 5–30 | W. | —1.43 | +4.38 |
| 5 | 3–30 | W. | —2.41 | +2.46 | 10 | 4– 0 | W. | —2.10 | +4.68 |
| 6 | 3–15 | W. | —2.72 | +3.20 | 11 | 5– 0 | W. | —4.12 | +5.26 |
| 7 | 3–15 | W. | —1.61 | +3.39 | 12 | 3–40 | W. | —4.64 | +4.72 |
| 8 | 3–15 | W. | —2.80 | +2.72 | 13 | 5–15 | W. | —2.49 | +6.00 |
| 9 | 7–30 | W. | —3.03 | +3.68 | 14 | 4–30 | W. | —3.20 | +4.85 |
| 10 | 3–30 | W. | —1.44 | +2.68 | 15 | 4–15 | W. | —3.26 | +4.33 |
| 11 | 5– 0 | W. | —3.30 | +2.80 | 16 | 8– 0 | W. | —4.76 | +8.24 |
| 12 | 5–30 | W. | —2.37 | +2.93 | 17 | 0–20 | W. | —2.70 | +7.67 |
| 13 | 3–30 | W. | —2.13 | +2.49 | 18 | 4–15 | W. | —1.72 | +6.02 |
| 14 | 3–30 | W. | —1.39 | +2.97 | 19 | 4–30 | W. | —2.01 | +5.31 |
| 15 | 3–30 | W. | —0.76 | +2.68 | 20 | 8– 0 | W. | —2.08 | —0.13 |
| 16 | 3–15 | W. | —0.10 | +2.88 | 21 | 5– 0 | W. | —1.33 | +0.77 |
| 17 | 3–15 | W. | —1.82 | +2.80 | 22 | 4–15 | W. | —0.40 | +1.79 |
| 18 | 3–15 | W. | —2.23 | +2.64 | 23 | 4–30 | W. | —0.23 | +3.19 |
| 19 | 3–15 | W. | —0.76 | +2.68 | 24 | 0–15 | W. | —0.44 | +2.09 |
| 20 | 3–15 | W. | —1.54 | +2.68 | 25 | 4–30 | W. | +0.25 | +1.66 |
| 21 | 3–15 | W. | —1.15 | +3.91 | 26 | 5– 0 | W. | —0.95 | —0.06 |
| 22 | 4–15 | W. | —2.35 | +3.64 | 27 | 5–30 | W. | —0.41 | +3.95 |
| 23 | 5–15 | W. | —1.74 | +3.03 | 28 | 4–30 | W. | —1.11 | +2.92 |
| 24 | 4– 0 | W. | —0.89 | +4.30 | 29 | 1– 0 | W. | —0.28 | +3.01 |
| 25 | 9–30 | W. | —0.34 | +3.20 | 30 | 4–30 | W. | —0.71 | +2.74 |
| 26 | 5–30 | W. | —1.88 | +4.04 | Dec. 1 | 4–30 | W. | —0.31 | +2.71 |
| 27 | 5– 0 | W. | —0.90 | +3.81 | 2 | 2– 0 | W. | —1.40 | +1.56 |
| 28 | 5– 0 | W. | —4.24 | +3.29 | 11 | 5– 0 | W. | +0.97 | +2.85 |
| 29 | 5– 0 | W. | —4.06 | +3.87 | 18 | 4–30 | W. | —5.46 | +4.02 |

Dec. 25, both collimators adjusted; south end of both lowered.
31, N. coll. adjusted; south end lowered.

# TABLE III.

## RECORD OF NADIR POINTS.

| Date. | Time. | Circle. | Nadir Point. |
|---|---|---|---|
| 1883. | h. m. | | |
| July 9 | 21–30 | W. | 125° 30′ 6″.17 |
| 10 | 21–40 | W. | 7.41 |
| 11 | 21–30 | W. | 7.53 |
| 12 | 21–30 | W. | 6.73 |
| 13 | 21–15 | W. | 6.24 |
| 14 | 21–30 | W. | 6.06 |
| 15 | 21–40 | W. | 6.73 |
| 16 | 21–20 | W. | 5.43 |
| 17 | 21–20 | W. | 5.20 |
| 18 | 21–20 | W. | 5.97 |
| 19 | 21–15 | W. | 6.36 |
| 20 | 21–40 | W. | .... |
| 21 | 21–40 | W. | 6.66 |
| 22 | 21–20 | W. | 5.44 |
| 23 | 21–30 | W. | 5.00 |
| 24 | 21–30 | W. | 4.92 |
| 25 | 23–20 | W. | 5.47 |
| 26 | 21–20 | W. | 4.39 |
| 27 | 22–10 | W. | 3.43 |
| 28 | 22–15 | W. | 3.91 |
| 29 | 22–30 | W. | 3.22 |
| 30 | 21–30 | W. | 3.76 |
| 31 | 21– 0 | W. | 4.10 |
| Aug. 1 | 22–25 | W. | 3.65 |
| 3 | 4–50 | W. | 3.89 |
| 4 | 3– 0 | W. | 4.55 |
| 5 | 3–50 | W. | 4.14 |
| 6 | 4– 0 | W. | 4.55 |
| 7 | 3– 0 | W. | 4.87 |
| 8 | 3– 0 | W. | 5.33 |
| 9 | 3–15 | W. | 10.51 |
| 10 | 4–30 | W. | 11.35 |
| 11 | 4–10 | W. | 11.76 |
| 12 | 3–45 | W. | 10.38 |
| 13 | 4–15 | W. | 10.43 |
| 15 | 4–20 | W. | 13.00 |
| 16 | 4–40 | W. | 11.52 |
| 17 | 4–10 | W. | 11.21 |
| *18 | 4–30 | W. | 10.32 |
| 19 | 4– 0 | W. | 10.51 |
| 20 | 7–15 | W. | 10.13 |
| 21 | 7–15 | W. | 11.30 |
| 22 | Adjusted azimuth at 5h. | | |
| 23 | 23– 0 | Microscope adj'd. | |

| Date. | Time. | Circle. | Nadir Point. |
|---|---|---|---|
| | h. m. | | |
| Aug. 24 | 7–30 | W. | 125°27′ 37″.28 |
| 25 | 7–30 | W. | 37.49 |
| 26 | 4–30 | W. | 37.04 |
| 27 | 7–45 | W. | 37.16 |
| 28 | 4– 0 | W. | 35.82 |
| 29 | 7–40 | W. | 35.50 |
| 30 | 5– 0 | W. | 35.57 |
| 31 | 7–40 | W. | 35.57 |
| Sept. 1 | 5–30 | W. | 35.27 |
| 2 | 3–30 | W. | 33.31 |
| 3 | 7–15 | W. | 37.84 |
| 4 | 9–30 | W. | 35.07 |
| 5 | 4–15 | W. | 36.27 |
| 6 | 3–30 | W. | 36.34 |
| 6 | 8– 0 | W. | 35.96 |
| 7 | 4–15 | Focus changed. | |
| 8 | 12–08 | W. | 34.38 |
| 9 | 8– 0 | W. | 34.20 |
| 11 | 9– 0 | W. | 34.91 |
| 12 | 8–30 | W. | 35.45 |
| 12 | 23–45 | W. | 34.20 |
| 13 | 6– 0 | Focus changed. | |
| 14 | 10– 0 | Focus changed. | |
| 15 | 8– 0 | W. | 35.77 |
| 15 | 10– 0 | Changed objective | |
| 16 | 3–15 | W. | 34.07 |
| 17 | 5– 0 | W. | 35.36 |
| 18 | 9– 0 | W. | 34.98 |
| 19 | 9–30 | W. | 34.68 |
| 20 | 10– 0 | W. | 33.76 |
| 21 | 9– 0 | W. | 34.61 |
| 22 | 9–30 | W. | 33.49 |
| 24 | 8– 0 | W. | 31.04 |
| 25 | 0–15 | W. | 29.08 |
| 25 | 3– 0 | W. | 29.45 |
| 26 | 5–15 | W. | 31.25 |
| 26 | 8–15 | W. | 31.27 |
| 27 | 10– 0 | W. | 30.96 |
| Oct. 2 | 5– 0 | W. | 30.94 |
| 3 | 4–45 | W. | 31.08 |
| 3 | 6–40 | W. | 31.08 |
| 10 | 4–15 | W. | 28.14 |
| 10 | 7–10 | W. | 28.42 |

*After August 17th, the microscopes were read both before and after the observations.

TABLE III, *Record of Nadir Points*—continued.

| DATE. | Time. | Circle. | Nadir Point. | DATE. | Time. | Circle. | Nadir Point. |
|---|---|---|---|---|---|---|---|
| 1883. | h m | | | | h m. | W. | |
| Oct. 14 | 22-30 | W. | 125° 27′ 26″.22 | Nov 23 | 21- 0 | W. | 125° 27′ 23″.76 |
| 15 | 4- 0 | W. | 26 .35 | 24 | 16- 3 | W. | 22 .22 |
| 15 | 7- 0 | W. | 26 .84 | 28 | 21- 0 | W. | 20 .91 |
| 15 | 23- 0 | W. | 25 .82 | 28 | 0- 3 | W. | 20 .67 |
| 16 | 1-30 | W. | 26 .03 | 28 | 0- 8 | W. | 21 .24 |
| 16 | 5- 0 | W. | 26 .86 | 30 | 21- 5 | W. | 22 .73 |
| 16 | 12- 0 | W. | 26 .59 | Dec. 4 | 22- 3 | W. | 21 .94 |
| | Sid. T. | | | | | | |
| 18 | 17- 7 | W. | 27 .66 | 4 | 0- 3 | W. | 22 .00 |
| 18 | 22- 2 | W. | 27 .87 | 4 | 2- 0 | W. | 22 .37 |
| 18 | 12- 7 | W. | 25 .83 | 4 | 13- 5 | W. | 22 .30 |
| 19 | 16- 2 | W. | 25 .73 | 5 | 23- 6 | W. | 22 .60 |
| 19 | 12- 5 | W. | 24 .44 | 5 | 0- 3 | W. | 22 .61 |
| 19 | 13- 8 | W. | 24 .62 | 5 | 2- 3 | W. | 23 .03 |
| 23 | 17- 7 | W. | 25 .13 | 8 | 0- 3 | W. | 25 .83 |
| 23 | 5- 1 | W. | 25 .73 | 8 | 2- 2 | W. | 24 .85 |
| 29 | 19- 0 | W. | 26 .02 | 10 | 0- 3 | W. | 22 .11 |
| Nov. 1 | 18- 3 | W. | 21 .92 | 10 | 2- 2 | W. | 22 .92 |
| 1 | 21- 9 | W. | 22 .26 | 10 | 13- 5 | W. | 22 .34 |
| 1 | 12- 9 | W. | 23 .19 | 17 | 17- 5 | W. | 23 .10 |
| 3 | 20- 3 | W. | 24 .13 | 18 | 17- 4 | W. | 23 .96 |
| 4 | 20- 0 | W. | 25 .27 | 19 | 17- 3 | W. | 25 .86 |
| 5 | 19- 5 | W. | 25 .03 | 20 | 18- 1 | W. | 25 .71 |
| 6 | 19- 5 | W. | 22 .56 | 20 | 17- 4 | W. | 23 .62 |
| 8 | 19- 4 | W. | 24 .05 | 21 | 18- 2 | W. | 24 .87 |
| 9 | 20- 0 | W. | 23 .40 | 23 | 17- 5 | W. | 25 .75 |
| 10 | 20- 0 | W. | 21 .69 | 24 | 18- 4 | W. | 25 .65 |
| 17 | 20- 0 | W. | 24 .51 | 24 | 17- 6 | W. | 24 .17 |
| 18 | 20- 0 | W. | 25 .01 | 25 | 18- 5 | W. | 24 .54 |
| 19 | 20- 5 | W. | 25 .11 | 27 | 17- 9 | W. | 21 .48 |
| 21 | 20- 5 | W. | 23 .43 | 28 | 18- 8 | W. | 21 .62 |
| 22 | 21- 3 | W. | 23 .17 | | | | |

## RECORD OF MICROSCOPE DISTANCES.

| Date, 1883. | | Time. | V to VI. 90° + | VI to VII. 90° + | VII to VIII. 90° + |
|---|---|---|---|---|---|
| | | h. | | | |
| July | 31 | 21.0 | 5."80 | 5."90 | 5."20 |
| August | 1 | 22.3 | 6.05 | 7.25 | 3.50 |
| | 3 | 4.9 | 6.70 | 5.65 | 4.60 |
| | 4 | 3.0 | 5.40 | 5.75 | 4.90 |
| | 5 | 3.9 | 6.20 | 5.10 | 6.00 |
| | 6 | 4.0 | 6.05 | 5.45 | 4.65 |
| | 7 | 3.1 | 6.40 | 6.75 | 4.25 |
| | 8 | 3.2 | 6.20 | 5.85 | 5.60 |
| | 9 | 3.4 | 7.15 | 6.10 | 3.95 |
| | 10 | 4.5 | 6.60 | 6.50 | 4.65 |
| | 11 | 4.2 | 6.55 | 7.50 | 3.45 |
| | 12 | 3.8 | 6.30 | 6.40 | 4.20 |
| | 13 | 3.5 | 7.25 | 6.80 | 3.10 |
| | 15 | 4.5 | 8.00 | 5.80 | 3.35 |
| | 16 | 4.7 | 6.85 | 6.55 | 3.85 |
| | 17 | 4.1 | 7.95 | 5.70 | 3.90 |
| | 18 | 4.3 | 6.28 | 6.03 | 4.68 |
| | 19 | 4.0 | 7.23 | 6.90 | 3.77 |
| | 20 | 7.2 | 7.30 | 6.45 | 2.57 |
| | 21 | 7.2 | 7.55 | 5.78 | 4.13 |
| | 22 | Azimuth adjusted | | | |
| | 24 | 7.4 | — 4.10 | 5.98 | 0.55 |
| | 25 | 7.5 | — 5.35 | 6.65 | 1.75 |
| | 26 | 4.4 | — 5.40 | 7.75 | 1.30 |
| | 27 | 7.7 | — 6.10 | 9.32 | 0.50 |
| | 28 | 4.0 | — 6.20 | 9.50 | 0.10 |
| | 29 | 7.9 | — 6.14 | 8.80 | 1.00 |
| | 30 | 5.0 | — 6.20 | 8.20 | 1.40 |
| | | Changed focus of V. | | | |
| | 31 | 7.7 | — 9.90 | 10.20 | 2.05 |
| September | 1 | 5.5 | — 7.50 | 10.65 | 1.70 |
| | 2 | 3.5 | — 7.90 | 10.40 | 1.70 |
| | 3 | 7.2 | — 6.60 | 9.95 | 0.50 |
| | 4 | 9.4 | — 5.05 | 7.80 | 1.15 |
| | 5 | 4.0 | — 4.40 | 7.37 | 0.35 |
| | 6 | 3.5 | — 5.15 | 7.25 | 1.10 |
| | 7 | Changed focus of tel. | | | |
| | 8 | 11.5 | — 8.00 | 7.70 | 0.90 |
| | 9 | 8.0 | — 5.70 | 7.65 | 1.00 |
| | 10 | No nadir this day. | | | |
| | 11 | 9.0 | — 6.80 | 7.50 | 2.15 |
| | 12 | 8.5 | — 7.30 | 7.45 | 2.45 |
| | 12 | 23.8 | — 7.30 | 7.80 | 2.75 |

RECORD OF MICROSCOPE DISTANCES.

| DATE, 1883. | TIME. | V to VI. | VI to VII. | VII to VIII. |
|---|---|---|---|---|
| | h. | " | " | " |
| September 15 | 8.0 | —6.65 | +7.45 | 3.45 |
| 16 | 3.3 | —6.50 | 7.55 | 2.75 |
| 17 | 5.0 | —5.40 | 7.00 | 1.30 |
| 18 | 9.0 | —5.05 | 7.75 | 0.10 |
| 19 | 9.4 | —5.00 | 8.65 | —0.60 |
| 20 | 10.0 | —5.90 | 7.90 | +0.80 |
| 21 | 9.0 | —5.75 | 7.70 | —0.15 |
| 22 | 9.0 | —8.05 | 9.65 | +1.15 |
| 24 | 8.0 | —8.65 | 14.10 | —0.05 |
| 25 | 0.0 | —10.00 | 12.85 | +1.65 |
| 26 | 8.0 | —9.35 | 12.80 | 0.60 |
| 27 | 10.0 | —9.40 | 13.15 | 0.70 |
| October 2 | 3.5 | —9.55 | 11.75 | 2.00 |
| 3 | 5.0 | —8.95 | 11.10 | +1.15 |
| 10 | 7.0 | —7.00 | 12.70 | —1.50 |
| 14 | 22.5 | —9.05 | 11.20 | —0.50 |
| 15 | 4.0 | —9.05 | 10.90 | —0.30 |
| 15 | 23.0 | —8.95 | 9.75 | —0.30 |
| 16 | 1.5 | —8.95 | 9.30 | +0.80 |
| 18 | 4.0 | —6.90 | 8.95 | +1.05 |
| 18 | 9.0 | —6.45 | 10.70 | +1.00 |
| 18 | 23.0 | —12.95 | 16.75 | —0.60 |
| 19 | 22.5 | —15.10 | 15.10 | +0.30 |
| | Sid. T. | | | |
| 23 | 1.5 | —14.20 | 16.50 | —1.75 |
| 29 | 19.0 | —12.85 | 16.05 | —1.35 |
| November 1 | 21.9 | —13.75 | 13.95 | —2.30 |
| 3 | 20.3 | —14.30 | 14.95 | —1.65 |
| 4 | 20.0 | —14.55 | 15.50 | —1.40 |
| 5 | 19.5 | —14.70 | 16.25 | —1.45 |
| 6 | 19.4 | —13.80 | 15.80 | —2.00 |
| 8 | 19.4 | —13.45 | 15.80 | —3.15 |
| 9 | 20.0 | —12.80 | 15.70 | —3.40 |
| 10 | 20.0 | —13.00 | 14.60 | —2.70 |
| 17 | 20.0 | —14.20 | 13.25 | —1.10 |
| 18 | 20.0 | —13.85 | 13.50 | —1.75 |
| 19 | 20.5 | —13.90 | 14.70 | —2.10 |
| 21 | 20.5 | —14.20 | 18.70 | —6.40 |
| 22 | 21.3 | —13.99 | 18.70 | —7.30 |
| 23 | 21.0 | —13.65 | 18.40 | —6.95 |
| 24 | 16.3 | —14.00 | 18.10 | —6.35 |
| 28 | 0.3 | —16.80 | 20.05 | —7.85 |
| 30 | 21.5 | —14.75 | 18.10 | —6.80 |
| December 4 | 0.3 | —14.40 | 16.50 | —5.20 |
| 4 | 13.5 | —14.90 | 17.00 | —5.55 |
| 5 | 0.3 | —15.10 | 16.90 | —4.70 |
| 8 | 2.2 | —16.35 | 18.35 | —5.85 |
| 10 | 2.2 | —14.25 | 18.15 | —7.55 |
| 17 | 19.5 | —15.00 | 14.95 | —6.90 |
| 18 | 17.4 | —13.90 | 13.00 | —7.85 |
| 19 | 17.3 | —12.70 | 12.60 | —8.70 |
| 20 | 17.4 | —12.75 | 12.65 | —8.65 |
| 23 | 17.5 | —15.45 | 17.70 | —5.80 |
| 24 | 17.6 | —14.80 | 17.85 | —7.45 |
| 27 | 17.9 | —14.20 | +15.95 | —7.00 |

The — sign denotes that the distance is less than 90°. After October 23 the times are sidereal.

RECORD OF ERROR OF RUNS.

| DATE. | TIME. | ERRORS. | | | | Mean Error. | Proportional correction to 1′ |
|---|---|---|---|---|---|---|---|
| | | V. | VI. | VII. | VIII. | | |
| 1883 | h m | ″ | ″ | ″ | ″ | ″ | ″ |
| July 8.. | 22–15 | +0.67 | +0.12 | +0.81 | —0.77 | +0.208 | —0.0016 |
| 11.. | 22–15 | +0.61 | +0.16 | +0.85 | —0.11 | +0.377 | —0.0020 |
| 12.. | 23–15 | +0.23 | —0.03 | —0.45 | —0.37 | —0.155 | +0.0009 |
| 14.. | 1–15 | +0.67 | +0.79 | —0.11 | —0.27 | +0.270 | —0.0015 |
| 16.. | 1–45 | +0.89 | +0.47 | +0.42 | —0.28 | +0.375 | —0.0021 |
| 17.. | 21–30 | +0.37 | +0.61 | —0.71 | —0.49 | —0.055 | +0.0003 |
| 18.. | 21–40 | +0.77 | +0.97 | +0.13 | —0.31 | +0.392 | —0.0022 |
| 20.. | 21–50 | +1.09 | +0.79 | —0.29 | —0.07 | +0.380 | —0.0021 |
| 22.. | 21–30 | +0.71 | +0.79 | —0.19 | —0.65 | +0.165 | —0.0009 |
| 24.. | 22–15 | +0.61 | +0.51 | —0.27 | —0.75 | +0.003 | 0.0000 |
| 26.. | 21–40 | +0.45 | +0.49 | —0.07 | —0.51 | +0.090 | —0.0005 |
| 28.. | 22–45 | +0.67 | +0.63 | —0.21 | —0.59 | +0.125 | —0.0007 |
| 30.. | 21–45 | +0.27 | +0.29 | +0.23 | —0.57 | +0.055 | —0.0003 |
| Aug. 3.. | 5–15 | +0.21 | +0.57 | —0.71 | —0.91 | —0.212 | +0.0012 |
| 5.. | 4–10 | +0.61 | +0.51 | —0.11 | —0.11 | +0.225 | —0.0012 |
| 8.. | 3–30 | +0.85 | 0.00 | —0.13 | —0.23 | +0.122 | —0.0007 |
| 11.. | 4–35 | +1.05 | +0.91 | —0.17 | +0.25 | +0.510 | —0.0028 |
| 15.. | 5–15 | +1.15 | +0.27 | +0.67 | —0.41 | +0.420 | —0.0023 |
| 18.. | 5–0 | +1.25 | +1.13 | +0.17 | —0.39 | +0.540 | —0.0030 |
| 22.. | 4–40 | +0.43 | —0.77 | —0.91 | —0.77 | —0.505 | +0.0029 |
| 22.. | 23–0 | Microscopes adjusted. | | | | | |
| 23*. | 5–0 | +0.43 | —0.73 | —0.05 | —0.41 | —0.190 | +0.0011 |
| 24.. | 5–8 | +0.65 | —0.61 | —0.21 | +0.39 | +0.055 | —0.0003 |
| 27.. | 8–20 | +0.69 | —0.53 | 0.00 | +0.71 | +0.218 | —0.0013 |
| 31†. | 4–30 | +0.68 | —0.25 | —0.11 | —0.51 | —0.060 | +0.0003 |
| Sept. 1.. | 7–0 | +0.67 | —0.45 | —0.71 | —0.07 | —0.140 | +0.0008 |
| 5.. | 7–0 | +0.35 | —0.17 | —0.59 | —0.69 | —0.270 | +0.0015 |
| 10.. | 5–0 | +0.35 | —0.83 | 0.00 | —0.65 | —0.283 | +0.0016 |
| 14.. | 4–0 | +0.73 | —0.63 | —0.35 | —0.81 | —0.265 | +0.0015 |
| 21.. | 3–45 | +0.51 | —0.55 | —0.37 | —0.67 | —0.270 | +0.0015 |
| 27.. | 5–30 | +0.67 | —0.41 | —0.33 | —0.11 | —0.045 | +0.0002 |
| Oct. 4.. | 10–0 | +0.05 | —0.95 | —0.99 | —1.08 | —0.742 | +0.0041 |
| 12.. | 3–30 | +0.39 | —0.59 | —0.75 | —0.33 | —0.320 | +0.0018 |
| 18.. | 9–0 | +0.29 | —2.97 | —0.75 | —1.13 | —1.140 | +0.0063 |
| 19‡. | 4–20 | ..... | —1.23 | ..... | ..... | —0.705 | +0.0039 |
| 23.. | 4–15 | +0.19 | —1.19 | +0.11 | —0.55 | —0.360 | +0.0020 |
| 29. | 5–0 | +0.11 | —0.73 | —0.11 | —0.91 | —0.410 | +0.0022 |
| Nov. 7.. | 21–30 | +0.03 | —1.07 | —0.77 | —0.65 | —0.615 | +0.0034 |
| 12.. | 5–0 | +0.01 | —0.68 | —0.49 | —0.53 | —0.405 | +0.0022 |
| 17.. | 5–30 | +0.35 | —0.75 | —0.59 | —0.41 | —0.325 | +0.0018 |
| 20.. | 23–0 | +0.27 | —1.91 | —0.79 | —0.41 | —0.710 | +0.0042 |
| 29.. | 0–0 | +0.71 | —1.37 | —0.49 | —0.49 | —0.385 | +0.0021 |
| Dec. 6.. | 5–30 | +0.49 | —1.07 | +0.11 | +0.02 | —0.112 | +0.0006 |
| 24.. | 4–0 | +0.23 | —0.95 | —0.33 | —0.95 | —0.500 | +0.0028 |

* Microscopes adjusted anew at 23h.

† Changed focus of microscope V.

‡ Changed focus of VI.

From curves which have been constructed from the preceding tables we have the following general conclusions:

For certain periods (as Aug. 10–23, Sept. 20–29, Nov. 1–15, Nov. 20–27) the levels of the N. and S. collimators appear to change at the same time and in the same direction. For other periods (notably Sept. 3–7) they certainly do not change together. Hence any conclusions as to the connection of *both* these levels with the temperature or rainfall are extremely doubtful, at best. We might expect rainfall to affect the soil below the foundations of the collimator piers, (and those of the instrument in a far less degree) while the temperature will affect the adjustments of the steel screws which hold the Y's, etc.

I. From the curves it appears that the level of the North Collimator varies with the temperature directly.

II. The level of the South Collimator does not appear so to vary.

III. The effect of rain-fall on the levels is not certain, nor marked. In a general way it appears that rain causes the north end of each collimator to rise. One would naturally suppose that the N. end of the N. C. and the S. end of the S. C. would fall, after a rain.

IV. The azimuth of the instrument varies directly with the temperature. As the temperature falls the W. end of the axis moves north.

V. The level of the instrument varies inversely as the temperature. As the temperature falls the W. end of the axis is raised.

IV and V are very important deductions. They show that the thermometer must be read at the time of determining both $a$ and $b$ and at intervals through an observing night, and that values of these constants must be interpolated varying as the *temperature.*

VI. A change of temperature changes the zenith point, and for short periods the change of zenith point appears to be proportional to the change of temperature, sometimes directly, sometimes inversely. *A priori* we know that this change arises from two causes; first a change in the tension of the spring which confines the objective in its cell, and

second a change in the position of the microscopes on their frame. It is probable that the first cause hardly shows in the daily curves which have been constructed. The microscopes themselves move slightly under the effect of changes of temperature, but it appears to be a matter of chance whether this movement is such as to increase or diminish the zenith point reading.

## III. — METHODS OF DETERMINING THE INSTRUMENTAL CONSTANTS.

### COLLIMATION CONSTANT.

The collimation-constant is determined by means of the horizontal collimators.

The telescope is first pointed towards the south collimator and the movable pair of wires in this collimator is so placed as to occupy the space in the field of the telescope between the wires $D_3$ and $D_4$,* or between $D_4$ and $D_5$. The telescope is then placed vertical, and the caps which cover the aperture in the cube being removed, the observer, at the north collimator, superposes the moveable pair of wires in the north collimator upon the movable pair in the south collimator, in the following manner: The pair in the north collimator is moved until the space between them is bisected by the east wire of the pair in the south collimator, and the micrometer head is read off. The west wire of the pair in the south collimator is then made to bisect the same space and the micrometer is again read. The mean of the two readings in the reading of the micrometer when the two pairs are superposed. All bisections are made by moving the micrometer in the direction of increasing readings. Ten bisections are made on each wire and the micrometer is set at the mean of the readings. The telescope is then pointed to the south collimator and four bisections of the space between its movable pair of wires are made by the A. R. micrometer

*For 1883 the spider line reticle was used. The process is similar for the glass reticle, which was inserted February 6, 1884. This reticle moves with the R. A. Micrometer-screw.

and the mean of the readings taken. The telescope is then pointed to the north collimator and the same process is repeated. The mean of the readings on the two collimators is the reading when the micrometer wire is in the line of collimation of the telescope.

Let

$c$ = collimation for the middle wire, uncorrected for diurnal aberration, and

$c_o$ = the same corrected,

$M_s$ = reading of micrometer when the telescope is pointed to the south collimator.

$M_n$ = reading of micrometer when the telescope is pointed to the north collimator.

$M_o$ = reading for co-incidence of micrometer and middle wire,

$R$ = 1 rev. of micrometer in seconds of time,

$\varphi$ = latitude,

Then for *Circle West* or *Circle East*;

$$c_o = R\left[M_o - \frac{M_n + M_s}{2}\right] - 0^s.021 \cos \varphi;$$

$$= 4^s.295\ (M_o - \tfrac{1}{2}\{M_n + M_s\}) - 0^s.015.$$

If we set the glass reticle so that the R. A. micrometer reads $\frac{1}{2}(M_n + M_s)$ then $c = 0$, and $c_o = -0^s.021 \cos \varphi$. The R. A. micrometer is set at $\frac{1}{2}(M_n + M_s)$ and clamped at this reading.

The collimation constant is usually determined once a week (Monday) the daily determinations detailed in the preceding tables having abundantly shown that the collimation remains constant for much longer periods. The probable error for a single setting has been found to be $\pm 0^s.010$, and of the concluded constant $0^s.003$.

## LEVEL CONSTANT.

The level constant is determined in two ways, (*a*) by the hanging level and (*b*) by observations of the nadir.

(*a*) The level is placed upon the axis of the telescope, which is pointed to the zenith or nadir, with the level tube on the

south side, and the level read. It is then placed with tube to the north of the telescope and again read. This constitutes a complete observation. Three complete observations are taken. The level tube is graduated from end to end and numbered from 0 to 60. When the west end of the bubble has the largest reading the readings of both ends are marked +; in the contrary case—

The level constant is

$$b = \frac{\Sigma w + \Sigma e.}{12} D.$$

In which D = 1 div. of the level = 0."083.

$$\text{The p. e. of } \frac{\Sigma w + \Sigma e}{4} \text{ is } \pm 0."010.$$

Or of $b$, it is $\pm$ 0."006 (from three reversals.)

(*b*) In the second method of determining $b$ the telescope is pointed to the Nadir box, and with the collimating eyepiece the wires of the reticle and their reflected images are seen in the field at the same time. The distance between $D^4$ (the mid-wire) and its image is then measured by means of the R. A. micrometer in the following manner: The micrometer wire is placed beyond the reflected image of the mid-wire in such a position that the distance between it and the reflected image of the mid-wire is equal to the distance between the mid-wire seen directly and by reflection. The mic. head is read off, and the micrometer wire is then placed beyond the mid-wire, so that the distance between it and the mid-wire seen directly is equal to the distance between the mid-wire seen directly and by reflection, and the mic. head is again read off. This operation is repeated five times.

Let

$b$ = level constant.

$c$ = collimation constant *uncorrectcd* for diurnal aberration.

M = micrometer reading when the wire is beyond reflected image of mid wire.

$M^1$ = micrometer reading when the wire is beyond the mid wire seen directly.

R = value of 1 rev. of R. A. micrometer.

Then

$$b = \tfrac{1}{6}.\ \mathrm{R}.\ (\mathrm{M} - \mathrm{M}') + \mathrm{c}.$$
$$= 4^{s}.295.\ \tfrac{1}{6}\ (\mathrm{M} - \mathrm{M}') + \mathrm{c}.$$

The probable error of a single determination of $b$ from each pair of measures of M and M′ by this method has been found to be $\pm 0^{s}.013$, assuming $c$ to have been determined with a *p. e.* of $\pm 0^{s}.003$. Five pairs of measures of $\mathrm{M} - \mathrm{M}'$ give $b$ with a *p. e.* of $0^{s}.006$, which is the same as *p. e.* of $b$ determined by three reversals of the spirit level. The value of $b$ varies *inversely* as the temperature, the coefficient being small, however. With the glass reticle let $\mathrm{M}_0$ be the reading of the R. A. micrometer when it is set for $c = 0$. M′ be the reading of the R. A. micrometer when the middle thread $O_7$ coincides with its reflected image, then

$$b = 4^{s}.295\ (\mathrm{M}' - \mathrm{M}_0)\ \text{Circle W.}$$
$$b = 4^{s}.295\ (\mathrm{M}_0 - \mathrm{M}')\ \text{Circle E.}$$

### AZIMUTH CONSTANT.

As it has been found to be impracticable to erect a meridian mark for controlling the azimuth of the instrument, the azimuth constant is determined in the usual way by combining observations of polar and time stars, or by observation of a circumpolar star both N. C. and L. C.

The azimuth constant has been found to vary directly as the temperature, the coefficient being small, however.

### NADIR-POINT.

To determine the zero of the circle by observations of the Nadir, the telescope is pointed vertically downwards and clamped. It is then moved by means of the slow motion in declination until the reflected image of the fixed pair of horizontal wires (seen by the collimating eyepiece and the illumination from a kerosene lamp shining through a screen of oiled silk) is at a distance of 8″ to 10″ north or south of the pair seen directly. The circle is then clamped and read, by its pointer and four microscopes. The observer then measures the distance between the horizontal wires and their reflected image in the following manner: The reflected

wires being south of the wires seen directly, the *single* movable Z. D. wire is placed *north* of the horizontal wires seen directly, so that the distance between it and the north horizontal wire is equal to the distance between the horizontal wires. The micrometer head is read off and the movable wire is then placed to the *south* of the reflected wires, observing the same conditions as to distance as in the former case. The distance, given by the difference of the two micrometer readings, is denoted by $\delta_1$. The micrometer wire is then placed alternately to the *south* of the wires seen directly and to the *north* of the reflected wires, in the same relative position to them as before, and the resulting distance is denoted by $\delta_2$. The apparent distance between the middle of the pair of wires seen directly and the middle of the pair seen reflected is

$$\Delta = \frac{\delta_1 + \delta_2}{2}$$

The correction to be applied to the circle reading, to obtain the Nadir-Point is $N = \pm R. \frac{1}{4} (\delta^1 + \delta^2)$,

where N = the correction in seconds of arc,

R = 1 rev. of micrometer-screw,

= 64″.527.

Use the *upper* sign when the reading for the reflected wire is *less* than the reading for the wires seen direct, and the *lower* sign when it is *greater*. The 4 microscopes are again read after the micrometric measures are concluded, and the mean of the two sets is taken as the circle reading to which N. is to be applied. From 108 cases it results that the *p. e.* of a single measure of $\delta_1$ or $\delta_2$ is ± 0.″19, and thus the *p. e.* of $\delta_1 + \delta_1$ is ± 0.″27. As the micrometer correction depends upon 4 measures of $\delta_1 + \delta_2$, its *p. e.* is ± 0.″14. The *p. e.* of the mean of 4 microscopes is 0.″06 (read twice), so that the *p. e.* of a concluded Nadir-Point is about 0.″15.

When the glass-reticle is employed the only spider lines in the micrometer box are those of the Z. D. micrometer, *viz.*: a pair of wires (wire A) and a single wire (wire B). Wire B is almost invariably employed in observation of stars and always in observing the nadir.

The sight line of the telescope is supposed to be defined in the field of view by the position of wire B when it is at 10.000 revolutions. To determine the nadir point the telescope is pointed to the nadir box and wire B is put in coincidence with its reflected image, four complete measures being made. Call the mean of these M. The correction to be applied to the circle reading to obtain the Nadir-Point is then (10.000—M) 64.″527 (circle W. and E.)

### HORIZONTAL POINTS FROM LEVELLED COLLIMATORS.

From the series of levels made by Miss SANBORN to determine the inequality of the pivots of the two collimators, it follows that the mean value of the probable error of a single determination of $p$ is $\pm 0.''16$. As $p$ is derived from the difference of two levellings, each of the latter is affected by a *p. e.* of 0.″11 which may be taken as the *p. e.* of the level-constant of a collimator. The two series from which this value is derived were made with extreme care, and it is not probable that this precision could be attained in a regular series of observations made at night. It represents rather the extreme limit of precision. The *p. e.* of the mean of 4 pointings of the telescope micrometer on the collimators is 0.″05, and the *p. e.* of the mean of 4 microscopes is 0.″08.

From these data it follows that the *p. e.* of a horizontal point is 0.″15; which is just the same as the *p. e.* of a concluded nadir-point. The nadir-observation is to be greatly preferred to the observation of the levelled collimators on account of the greater convenience of the observation of the nadir, which can be equally well made in the day or in the night, while the collimators are more difficult to observe at night when they are required most.

### EQUATOR-POINT.

To determine the equator-point of the circle in differential observations, the fundamental stars of the *Berliner Jahrbuch* are alone used. These are completely reduced, and each corrected circle-reading compared with the declination of the *Jahrbuch* gives one value of the equator-point.

From what has gone before it appears that the various processes relating to the determinations of declination are affected with probable errors as follows:

The probable error of a Nadir-Point (obtained by the programme previously described) is $\pm 0''.15$. This accidental error is to be further increased by the uncertainty due to the division-errors of the circle. The *p. e.* of the reading of a single microscope on a single division is $\pm 0''.16$. Supposing the circle to be perfectly divided and to retain its shape, the mean of 4 microscopes has a *p. e.* of $\pm 0''.08$.

The *p. e.* of an Equator-Point from a single fundamental star, with the microscopes read once has been found to be $\pm 0''.62$. This includes the effect of deviations of the standard declinations from those of a truly normal system.

From a preliminary discussion of the observations of certain stars which have been observed for latitude, for each of which the microscopes have been read twice at each observation, it follows that the *p. e.* of an Equator-Point from a single star with microscopes read twice may be reduced to $\pm 0''.53$.

In the ordinary practice of determining the Equator-Point the microscopes are read twice whenever this does not prevent the observation of some one of the stars whose declinations are required. We may fairly assume the *p. e.* of an Equator-Point from a single star to be $\pm 0''.60$.

Then we shall have the following table:

*P. e.* of an equator-point from 9 stars $\pm 0''.20$;
8 stars $\pm 0''.21$;
7 stars $\pm 0''.23$;
6 stars $\pm 0''.25$;
5 stars $\pm 0''.27$:

And the *p. e.* of a single declination depending on an equator-point derived

From 9 stars $\pm 0''.65$ )
From 5 stars $\pm 0''.68$ )

If a star is observed three times *Circle E.* and three times *Circle W.* (and if there is no systematic difference *Circle E.*

and *W.*) the *p. e.* of a concluded (catalogue) declination from six observations should be about 0″.3.

It can only be decided by trial whether this degree of precision can be realized. As the numbers above depend upon actual observations reduced with the Pulkova Refractions, and as it appears from our observations of Refraction Stars, that we may expect to satisfy the normal system of star-places better by a slightly changed refraction, it is to be hoped that the *p. e.* of a single declination will not be much above 0″.65. ARGELANDER (*Bonner Beob.* vi, S. xii) found for bright equatorial stars ±0″.60.

### ERROR OF RUNS.

The correction for error of runs of the microscopes is determined by means of the divisions of the extra arc. The arc being brought into the field of one of the microscopes, five pointings with the microscope micrometer are made upon the division *b* and then five upon the division *a* whose distance from *b* is 179″.93.

Let B = the mean of the pointings on b.

A = " " " " " " a.

$\Delta$ = distance in seconds of arc between b and a.

$E_I$ = *correction* for runs, for microscope I.

$E_I = \Delta - [180'' + (A - B)]$.

$= 179''.93 - [180'' + (A - B)]$.

$E_{II}$, $E_{III}$ and $E_{IV}$ are formed in the same way and

$$E = \frac{E_I + E_{II} + E_{III} + E_{IV}}{4}.$$

The proportional-correction to 1″ is $\frac{E}{180}$; and this quantity is to be multiplied by the number of seconds between the mean of the four microscopes and zero, and applied to the circle reading.

This process is the same *circle E* or *circle W.*

### CORRECTION FOR INCLINATION OF THE MICROMETER-WIRE.

If a polar star is used to determine the inclination, it is bisected at several (sidereal) times $t'$, $t''$, $t'''$ by the micrometer which will read

$$M', M'', M'''.$$

Let $t$ be the time of transit over the meridian of the instrument, and $m$ an (assumed) micrometer reading corresponding to $t$, and $dm$ the correction to $m$. Let $\mu$ be the reduction to the meridian. Then each observation gives an equation of the form, $m - M' = -dm - \mu - \cos\delta . \sin(t' - t)$ I. From all the bisections I is to be found; and the correction $i''$ for a star in the parallel $\delta$ is

$$i'' = I . \cos\delta . \sin 15 . t^s .$$

$\delta$ is the star's declination; $t = \tau - m$ (BESSEL'S $m$); $\tau$ is the hour angle counted towards the East, positive; I is the inclination, positive when with the telescope pointed to the south horizon, the east end of the horizontal thread is below the horizon.

### THE FLEXURE CONSTANT.

To determine the flexure by the collimators they are turned in their Ys, so that their micrometer wires are horizontal and *near the middle of the field.* This precaution is important. The wires of the north (or south) collimator are superposed upon those of the other, in the same way as before described. Temperatures are read from thermometers in front of the objectives of the two collimators and over the circle and no series has been accepted when these three thermometers did not agree within four degrees *Fahr.* during the whole of the process. In order to obtain such constancy of temperature, special care has to be taken with the ventilation of the room. The actual *measures* are usually made with the shutters closed, but they usually have been open for some hours previous to the observation. Ten pointings of the N. C. on the S. C. are made and the micrometer is set to the mean of the readings. The *p. e.* of a single setting

(two measures) is ± 0″.15, and of the mean of the 10 it is ±0″.047. We may suppose half of this *p. e.* to belong to the N. C. and half to the S. C.

The telescope is then directed towards the S. C. and the micrometer zero determined. The *p. e.* of a single determination (two measures) is ±0″.069. Four settings are made; *p. e.* = ±0″.035. The circle is then clamped and the four microscopes read: *p. e.* = ±0″.08. The pair of horizontal wires in the S. C. is then bisected by the Z. D. micrometer wire, nine times. The *p. e.* of a single bisection is ±0″.096; of the mean of nine it is ±0″.032. The four microscopes are again read, and as their mean is combined with the mean of the preceding reading of the same four, the *p. e.* of the resulting correction to the circle-reading on account of microscopes is ±0″.057. As far as the telescope and microscopes are concerned we have the *p. e.* of the setting on the S. C. ±0″.074. We may allow 0″.024 as the *p. e.* of the position of the S. C. (that of the N. C. being assumed to be the same). Hence the *p. e.* of the whole operation of setting the telescope on one end of the line determined by the collimators may be taken as ±″0.078. The telescope is then turned through the zenith and set on the N. C. in precisely the same way; the operation involving the reading of four microscopes before and after, and making nine settings of the Z. D. micrometer on the wires of the N. C. The *p. e.* of the whole operation of setting the telescope on the other end of the line above described is ±0″.078.

The telescope is now unclamped, and the whole operation is repeated on the N. C. It is then turned through the nadir and set on the S. C. as before. In each case the *p. e.* of the whole operation of determining one end of an arc of 180° is ±0″.078. Therefore each arc of 180° is determined with a *p. e.* of ±0″.110, and the final value of the flexure from both arcs with a *p. e.* of ±0″.08. Hence if the flexure is not above 0″.2, the operation must be very carefully conducted in order to find any satisfactory results.

At the end of the series the reading of one collimator on the other is tested. In case the co-incidence changes, the series should be rejected. We have occasionally distributed a small change proportionally to the time.

Let the actual circle readings (with the micrometer correction applied) be

A for the first pointing on S. C.;
B for the first pointing on N. C.; } through zenith.

C for the second pointing on N. C.;
D for the second pointing on S. C.; } through nadir.

h = horizontal flexure.

Ordinarily B and C are identical.

$$\textit{Circle West} \begin{cases} 2h = 180° + (B - A) \\ 2h = 180° + (C - D) \end{cases}$$

$$\textit{Circle East} \begin{cases} 2h = 180° + (A - B) \\ 2h = 180° + (C - D) \end{cases}$$

As a matter of fact, the flexure will be determined in the course of a series of observations on two selected lists of B. J. stars, one the latitude-list, the other the refraction-list. It is intended to deduce from these stars such values of the refraction, the latitude and the flexure as will best satisfy AUWERS' fundamental system, and in future to make observations in both co-ordinates strictly differential with this system.

## IV. — REDUCTION OF OBSERVATIONS IN RIGHT ASCENSION.

### REDUCTION TO THE MIDDLE THREAD.

The telescope has two reticles. During 1883 the spider-line reticle was employed. Subsequently, the glass reticle will take its place. The equatorial intervals of both reticles have been previously given. It only remains to give the nomenclature of each.

### THE SPIDER-LINE RETICLE.

This contains seven groups of wires:

$A_{1,2,3}$; $B_{1,2,3,4}$; $C_{1,2,3}$; $D_{1,2,3,4,5,6,7}$; $E_{1,2,3}$; $F_{1,2,3,4}$; $G_{1,2,3}$

In all twenty-seven wires. All observations are reduced to $D_4$. The wires retain their names, *Circle East* or *Circle West.* An equatorial star, *Circle W.*, crosses them in the order A....G. The revolutions of the R. A. micrometer increase in the direction G....A.

If $F^s$ is the equatorial interval of a thread from the middle wire, a transit over that wire is reduced to the mid-wire by the formula $f^s = F^s \sec. \delta$ up to 82° north declination. For stars farther north the complete formula Sin. $15\,t = \sin. 15\,F^s \sec. \delta \sin. 1''$ is used. $f^s = 15\,t$ = the reduction for the parallel of the star. If the transits are registered by a mean time clock, for $F^s$ in the above formulæ the quantity 0.99727 $F^s$ must be substituted.

### THE GLASS-RETICLE.

This contains 5 groups of wires; $L_1$; $M_{1,2,3}$; O (13 wires), $P_{1,2,3}$, $Q_1$.

The central group O has 5 wires for its whole length, *viz.*: $O_1$, $O_4$, $O_7$, $O_{10}$, $O_{13}$. For half the length of the reticle (in Z. D) there are two wires, $O_2$, $O_3$, $O_5$, $O_6$, etc., ruled between each pair of long lines. The intervals of $O_1$, $O_2$, etc., for *Polaris* are about 30$^s$.

This whole reticle moves with the R. A. micrometer screw. L is nearest to the micrometer head. The wires always retain the same names. An equatorial star *circle west* crosses the wires in the order L ..... Q.

The reticle of our meridian circle is so arranged that a number of threads lie on either side of the central groups over which the right ascensions will be observed. In the usual practice the star is bisected *once* before the observation of R. A., and *once* after the observation. After the first bisection in Dec. is made, the observer has to take his chronograph-key and observe the transits, and then to lay down this key and to make the second bisection. It is taken for granted that no bisection will be recorded unless it is satisfactory. For example, if no satisfactory bisection can be made before the transits, the observer always knows that he has sufficient time after them, to make at least two bisections, and he can therefore be critical. The transits, how-

ever, must be taken over certain wires, and it is possible that the precision of these transit-observations may be influenced by the knowledge of the observer that he has one or more bisections to make after them. It is possible to observe the declination on two wires *after* the transit (case I); on two wires *before* the transit (case II); on one wire *before* and one wire *after* the transit (case III). The question is, is one of these three ways preferable to the two others? or does the right-ascension observation suffer in precision from either of these arrangements of the declination bisections?

The answer to this question should decide the method to be habitually adopted. Observations made specially to answer the question will not be so valuable as others made without reference to it. I have therefore chosen 60 observations made by observer F. with the Washington Transit Circle in 1872, in which instrument the wires are arranged similarly to our own. In 20 of these observations the transits over 9 wires were observed first and the declination was observed after the transits. (Case I.) In another 20 the declination was observed over two wires *before* the transits. (Case II.) In another 20, one bisection was made *before* and one *after* the transits. (Case III.)

The *average mean error* of a single transit over a single wire was for

| | Case I. | Case II. | Case III. |
|---|---|---|---|
| E = | 0ˢ.038. | 0ˢ.025. | 0ˢ.025. |

It appears that the precision is practically the same in the three cases, and that there is no reason to prefer one method to another. To eliminate the inclination of the micrometer-thread, the method III will be habitually followed.

### FORMULÆ.

The observations in R. A. are reduced by the following formula:

$$\text{R. A.} = T^m + (\Delta T + m) + n \tan \delta \begin{cases} + c \sec \delta - 0^s.021 \cos \varphi \sec \delta \\ + c' \sec \delta, \end{cases}$$

$T^m$ = clock time of transit over the middle wire, corrected for the rate of the clock; $\Delta T$ = clock correction. For stars

L. C. substitute $180° - \delta$ for $\delta$. With the glass-reticle c sec $\delta$ is made zero by adjustment.

The star places on which $\Delta$ T, $m$ and $n$ depend are taken from the list of the *Berliner Jahrbuch*, and all stars of this list, observed in the course of a night's work, are divided into two groups, designated as polar and time stars.

The polar group contains stars north of 65° north declination, the time stars are those south of this limit.

For the determination of $(\Delta T + m)$ and $n$, each known star observed gives an equation of the form

$$\text{R. A.} - T^m - c' \sec \delta = [\Delta T + m] + n \tan \delta.$$

$$\text{or R. A.} - T^m + 0^s.015 \sec \delta =$$

The mean of the equations resulting from the time stars is combined with the equation from each polar and the value of $n$ is determined. The arithmetical mean of the individual values of $n$ is generally adopted, and being substituted in the equation from the time stars, the value of $\Delta T + m$ is determined.

As a check, the value of $n$ is substituted in each of the equation from the time stars and the individual values of $\Delta T + m$ computed. The mean of these values should agree with the value first determined.

For the determination of the clock correction $\Delta$ T, it is necessary to read the level once every hour and thus determine $b$. Then

$$m = b \sec \varphi - n \tan \varphi; \text{ and } \Delta T = (\Delta T + m) - m.$$

For an observation for the clock correction alone it is sometimes convenient to employ the formula

$$\text{A. R.} = T_m + \Delta T + A\,a + B\,b \begin{cases} + C.\,c' \\ \text{or} \\ - 0^s.015 \sec \delta. \end{cases}$$

The quantities

$$A = \frac{\sin(\varphi - \delta)}{\cos \delta}, \quad B = \frac{\cos(\varphi - \delta)}{\cos \delta}, \quad C = \sec \delta, \quad D = \tan \delta.$$

are given in Prof. WATSON'S (ms.) Reduction Tables for each star.

Where the hourly rate is very unsteady the following process may be used. The mean clock correction from a group of three or more fundamental stars is taken as corresponding to the mean time of the observations. The apparent rates between groups are then formed, and platted on squared paper with the times as abscissas and the apparent hourly rates as ordinates. Each apparent hourly rate is assumed to belong to the middle time between the two groups from which it is derived. A smooth curve is then drawn through the extremities of the ordinates, and the final hourly rate for any time can be at once read from the scale of ordinates. The clock correction at any moment can be had by adding to the clock correction at the last preceding group the area included between the axis of abscissas, the curve, the ordinate through the last preceding clock correction and the ordinate through the time for which the clock correction is required. This area is quickly and accurately measured by an AMSLER'S planimeter.

## V.—REDUCTION OF OBSERVATIONS IN DECLINATION.

$$\text{For} \left\{ \begin{matrix} \text{Circle West} \\ \text{Circle East} \end{matrix} \right\} \text{greater declinations}$$

$$\text{correspond to} \left\{ \begin{matrix} \text{greater} \\ \text{less} \end{matrix} \right\} \text{Circle readings.}$$

The observations are reduced by the formula

$$C_o = C + R_{ref} + R_{mic} + R_{mer} + R_{in} + R_r + R_{fl} + R_{div} + \Delta\varphi.$$

C = the reading of the setting microscope plus the mean of the four microscopes;

$R_{ref}$ = the correction for refraction taken from the Pulkova Tables, unaltered (for the present).

*Circle West.*

$$R_{ref} \text{ is} \left\{ \begin{matrix} \text{negative} \\ \text{positive} \end{matrix} \right\} \text{for stars} \left\{ \begin{matrix} \text{south} \\ \text{north} \end{matrix} \right\} \text{of the zenith.}$$

*Circle East.*

$R_{ref}$ is $\left\{\begin{matrix}\text{positive}\\\text{negative}\end{matrix}\right\}$ for stars $\left\{\begin{matrix}\text{south}\\\text{north}\end{matrix}\right\}$ of the zenith.

$R_{mic}$ = the micrometer correction to reduce the place of the star as actually bisected, to the mean between the two fixed horizontal threads of the spider-line reticle, or to 10.0 revolutions for the glass reticle.

*Circle West and East.*

$R_{mic}$ is *positive,* when the micrometer reading on the star is *less* than the reading on the mean of the fixed threads (the "micrometer-zero"); *negative* when the reading on the star is *greater* than the micrometer-zero.

$R_{mer}$ = the reduction to the meridian can be computed from

$$R_{mer} = \pm\left[\frac{2\sin.^2 \frac{1}{2}t.}{\sin. 1''.}\cdot\frac{\sin. 2\delta}{2} + \frac{n.\sin t.\cos^2\delta}{\sin. 1''.}\right]$$

The second term will only be sensible when the instrumental $n$ is large, and then only for equatorial stars observed at side threads.

For stars seen *direct* the upper sign relates to *Circle East,* the lower to *Circle West.* For stars S. P. the declination is counted over the pole. For stars seen *reflected* the upper sign relates to *Circle West,* the lower to *Circle East* for stars U. C.

If $\delta$ is always taken less than 90°, and the numerical value of $R_{mer}$ is computed regardless of sign as in the following table, then

*Circle West* (stars seen directly.)

$R_{mer}$ = *minus* for North Stars U. C.
= *plus* " South "
= *plus* " North " L. C.

*Circle West* (stars seen by reflection.)

$R_{mer}$ = *plus* for North Stars U. C.
= *minus* " South "
= *minus* " North " L. C.

*Circle East* (stars seen directly.)

$R_{mer}$ = *plus* for North Stars U. C.
= *minus* " South "
= *minus* " North " L. C.

*Circle East* (stars seen by reflection.)

$R_{mer}$ = *minus* for North Stars U. C.
= *plus* " South "
= *plus* " North " L. C.

The numerical value of $R_{mer}$ can be taken directly from COFFIN and HUBBARD'S Reduction Tables, Washington Astronomical Observations, 1845, Vol. I, Appendix I, p. 78, part of which is reprinted on pages 90 and 91.

HOUR-ANGLE.

| Dec. | | 10ˢ | 15ˢ | 20ˢ | 25ˢ | 30ˢ | 35ˢ | 40ˢ | 45ˢ | 50ˢ | 55ˢ | 60ˢ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1° | 89° | 0″.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.03 | 0.03 |
| 2 | 88 | .00 | .00 | .01 | .01 | .02 | .02 | .03 | .04 | .05 | .06 | .07 |
| 3 | 87 | .00 | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .09 | .10 |
| 4 | 86 | .00 | .00 | .01 | .02 | .03 | .05 | .06 | .08 | .09 | .11 | .14 |
| 5 | 85 | .00 | .01 | .02 | .03 | .04 | .06 | .07 | .10 | .12 | .14 | .17 |
| 6 | 84 | 0.01 | 0.01 | .02 | 0.04 | 0.05 | 0.07 | 0.09 | 0.11 | 0.14 | 0.17 | 0.20 |
| 7 | 83 | .01 | .01 | .03 | .04 | .06 | .08 | .10 | .13 | .16 | .20 | .24 |
| 8 | 82 | .01 | .02 | .03 | .05 | .07 | .09 | .12 | .15 | .19 | .23 | .27 |
| 9 | 81 | .01 | .02 | .03 | .05 | .08 | .10 | .13 | .17 | .21 | .26 | .30 |
| 10 | 80 | .01 | .02 | .04 | .06 | .08 | .11 | .15 | .19 | .23 | .28 | .34 |
| 11 | 79 | 0.01 | 0.02 | 0.04 | 0.06 | 0.09 | 0.12 | 0.16 | 0.21 | 0.26 | 0.31 | 0.37 |
| 12 | 78 | .01 | .02 | .04 | .07 | .10 | .13 | .18 | .22 | .28 | .33 | .40 |
| 13 | 77 | .01 | .03 | .05 | .07 | .11 | .14 | .19 | .24 | .30 | .36 | .43 |
| 14 | 76 | .01 | .03 | .05 | .08 | .11 | .16 | .20 | .26 | .32 | .39 | .46 |
| 15 | 75 | .01 | .03 | .05 | .08 | .12 | .17 | .22 | .28 | .34 | .41 | .49 |
| 16 | 74 | 0.01 | 0.03 | 0.06 | 0.09 | 0.13 | 0.18 | 0.23 | 0.29 | 0.36 | 0.44 | 0.52 |
| 17 | 73 | .01 | .03 | .06 | .09 | .14 | .19 | .24 | .31 | .38 | .46 | .55 |
| 18 | 72 | .02 | .04 | .06 | .10 | .14 | .20 | .26 | .33 | .40 | .48 | .58 |
| 19 | 71 | .02 | .04 | .07 | .10 | .15 | .21 | .27 | .34 | .42 | .51 | .60 |
| 20 | 70 | .02 | .04 | .07 | .11 | .16 | .21 | .28 | .35 | .44 | .53 | .63 |
| 21 | 69 | 0.02 | 0.04 | 0.07 | 0.11 | 0.16 | 0.22 | 0.29 | 0.37 | 0.46 | 0.55 | 0.66 |
| 22 | 68 | .02 | .04 | .08 | .12 | .17 | .23 | .30 | .38 | .47 | .57 | .68 |
| 23 | 67 | .02 | .05 | .08 | .12 | .17 | .24 | .31 | .40 | .49 | .59 | .71 |
| 24 | 66 | .02 | .05 | .08 | .13 | .18 | .25 | .32 | .41 | .51 | .61 | .73 |
| 25 | 65 | .02 | .05 | .08 | .13 | .18 | .26 | .33 | .42 | .52 | .63 | .75 |
| 26 | 64 | 0.02 | 0.05 | 0.09 | 0.13 | 0.19 | 0.26 | 0.34 | 0.43 | 0.54 | 0.65 | 0.77 |
| 27 | 63 | .02 | .05 | .09 | .14 | .20 | .27 | .35 | .45 | .55 | .67 | .79 |
| 28 | 62 | .02 | .05 | .09 | .14 | .20 | .28 | .36 | .46 | .56 | .68 | .81 |
| 29 | 61 | .02 | .05 | .09 | .14 | .21 | .28 | .37 | .47 | .58 | .70 | .83 |
| 30 | 60 | .02 | .05 | .09 | .15 | .21 | .29 | .38 | .48 | .59 | .71 | .85 |
| 31 | 59 | 0.02 | 0.06 | 0.10 | 0.15 | 0.22 | 0.30 | 0.38 | 0.49 | 0.60 | 0.73 | 0.87 |
| 32 | 58 | .02 | .06 | .10 | .15 | .22 | .30 | .39 | .50 | .61 | .74 | .88 |
| 33 | 57 | .02 | .06 | .10 | .16 | .22 | .31 | .40 | .51 | .62 | .75 | .90 |
| 34 | 56 | .03 | .06 | .10 | .16 | .23 | .31 | .40 | .51 | .63 | .77 | .91 |
| 35 | 55 | .03 | .06 | .10 | .16 | .23 | .32 | .41 | .52 | .64 | .78 | .92 |
| 36 | 54 | 0.03 | 0.06 | 0.10 | 0.16 | 0.23 | 0.32 | 0.41 | 0.53 | 0.65 | 0.78 | 0.93 |
| 37 | 53 | .03 | .06 | .10 | .16 | .24 | .32 | .42 | .53 | .65 | .79 | .94 |
| 38 | 52 | .03 | .06 | .11 | .17 | .24 | .32 | .42 | .54 | .66 | .80 | .95 |
| 39 | 51 | .03 | .06 | .11 | .17 | .24 | .33 | .43 | .54 | .67 | .81 | .96 |
| 40 | 50 | .03 | .06 | .11 | .17 | .24 | .33 | .43 | .54 | .67 | .81 | .97 |
| 41 | 49 | 0.03 | 0.06 | 0.11 | 0.17 | 0.24 | 0.33 | 0.43 | 0.55 | 0.67 | 0.82 | 0.97 |
| 42 | 48 | .03 | .06 | .11 | .17 | .24 | .33 | .43 | .55 | .68 | .82 | .98 |
| 43 | 47 | .03 | .06 | .11 | .17 | .24 | .33 | .43 | .55 | .68 | .82 | .98 |
| 44 | 46 | .03 | .06 | .11 | .17 | .24 | .33 | .44 | .55 | .68 | .82 | .98 |
| 45 | 45 | 0.03 | 0.06 | 0.11 | 0.17 | 0.24 | 0.33 | 0.44 | 0.55 | 0.68 | .82 | .98 |

HOUR ANGLE.

| Dec. | | 65ˢ | 70ˢ | 75ˢ | 80ˢ | 85ˢ | 90ˢ | 95ˢ | 100ˢ | 105ˢ | 110ˢ | 115ˢ | 120ˢ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1° | 89° | 0.04 | 0.05 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.09 | 0.10 | 0.11 | 0.12 | 0.14 |
| 2 | 88 | .08 | .09 | .11 | .12 | .14 | .15 | .17 | .19 | .21 | .23 | .25 | .27 |
| 3 | 87 | .12 | .14 | .16 | .18 | .20 | .23 | .26 | .28 | .31 | .34 | .37 | .41 |
| 4 | 86 | .16 | .19 | .21 | .24 | .27 | .31 | .34 | .38 | .42 | .46 | .50 | .55 |
| 5 | 85 | .20 | .23 | .27 | .30 | .34 | .38 | .42 | .47 | .52 | .57 | .62 | .68 |
| 6 | 84 | 0.24 | 0.28 | 0.32 | 0.36 | 0.41 | 0.46 | 0.51 | 0.57 | 0.62 | 0.68 | 0.75 | 0.82 |
| 7 | 83 | .28 | .32 | .37 | .42 | .48 | .53 | .60 | .66 | .73 | .80 | .87 | .95 |
| 8 | 82 | .32 | .37 | .42 | .48 | .54 | .61 | .68 | .75 | .83 | 0.91 | 0.99 | 1.08 |
| 9 | 81 | .36 | .41 | .47 | .54 | .61 | .68 | .76 | .84 | 0.93 | 1.02 | 1.11 | .21 |
| 10 | 80 | .40 | .46 | .52 | .60 | .67 | .76 | .84 | .93 | 1.02 | 1.13 | 1.23 | .34 |
| 11 | 79 | 0.43 | 0.50 | 0.57 | 0.65 | 0.74 | 0.83 | 0.92 | 1.02 | 1.12 | 1.23 | 1.34 | 1.47 |
| 12 | 78 | .47 | .54 | .62 | .71 | .80 | .90 | 1.00 | .11 | .21 | .34 | .46 | .60 |
| 13 | 77 | .51 | .59 | .67 | .76 | .86 | .97 | .08 | .19 | .31 | .45 | .57 | .72 |
| 14 | 76 | .54 | .63 | .72 | .82 | .92 | 1.04 | .15 | .28 | .40 | .55 | .68 | .84 |
| 15 | 75 | .58 | .67 | .77 | .87 | .98 | 1.10 | .23 | .36 | .50 | .65 | .80 | .96 |
| 16 | 74 | 0.61 | 0.71 | 0.81 | 0.92 | 1.04 | 1.17 | 1.30 | 1.44 | 1.59 | 1.75 | 1.90 | 2.08 |
| 17 | 73 | .64 | .75 | .86 | 0.98 | .10 | .23 | .38 | .52 | .68 | .84 | 2.01 | .19 |
| 18 | 72 | .68 | .78 | .90 | 1.03 | .16 | .30 | .45 | .60 | .76 | 1.94 | .12 | .31 |
| 19 | 71 | .71 | .82 | .94 | .07 | .21 | .36 | .52 | .68 | .84 | 2.03 | .22 | .42 |
| 20 | 70 | .74 | .86 | .99 | .12 | .27 | .42 | .58 | .75 | .93 | 2.12 | .32 | .52 |
| 21 | 69 | 0.77 | 0.89 | 1.03 | 1.17 | 1.32 | 1.48 | 1.65 | 1.82 | 2.01 | 2.21 | 2.41 | 2.63 |
| 22 | 68 | .80 | .93 | .06 | .21 | .37 | .53 | .71 | .89 | .09 | .29 | .50 | .73 |
| 23 | 67 | .83 | .96 | .10 | .25 | .42 | .59 | .77 | 1.96 | .16 | .37 | .59 | .82 |
| 24 | 66 | .86 | 0.99 | .14 | .30 | .46 | .64 | .83 | 2.03 | .23 | .45 | .68 | .92 |
| 25 | 65 | .88 | 1.02 | .18 | .34 | .51 | .69 | .89 | .09 | .29 | .53 | .76 | 3.01 |
| 26 | 64 | 0.91 | 1.05 | 1.21 | 1.37 | 1.55 | 1.74 | 1.94 | 2.15 | 2.36 | 2.60 | 2.84 | 3.09 |
| 27 | 63 | .93 | .08 | .24 | .41 | .59 | .79 | 1.99 | .21 | .43 | .67 | .92 | .18 |
| 28 | 62 | .96 | .10 | .27 | .45 | .63 | .83 | 2.04 | .26 | .49 | .74 | 2.99 | .26 |
| 29 | 61 | 0.98 | .13 | .30 | .48 | .67 | .87 | .09 | .31 | .54 | .80 | 3.06 | .33 |
| 30 | 60 | 1.00 | .16 | .33 | .51 | .71 | .91 | 2.13 | .36 | .60 | .86 | .12 | .40 |
| 31 | 59 | 1.02 | 1.18 | 1.36 | 1.54 | 1.74 | 1.95 | 2.17 | 2.41 | 2.65 | 2.91 | 3.18 | 3.47 |
| 32 | 58 | .04 | .20 | .38 | .57 | .77 | 1.98 | .21 | .45 | .70 | 2.96 | .24 | .53 |
| 33 | 57 | .05 | .22 | .40 | .59 | .80 | 2.02 | .25 | .49 | .74 | 3.01 | .29 | .59 |
| 34 | 56 | .07 | .24 | .42 | .62 | .83 | .05 | .28 | .53 | .78 | .06 | .34 | .64 |
| 35 | 55 | .08 | .26 | .44 | .64 | .85 | 2.08 | 2.31 | .56 | .82 | 3.10 | .39 | .69 |
| 36 | 54 | 1.10 | 1.27 | 1.46 | 1.66 | 1.87 | 2.10 | 2.34 | 2.59 | 2.85 | 3.14 | 3.43 | 3.73 |
| 37 | 53 | .11 | .28 | .47 | .68 | .89 | .12 | .37 | .62 | .88 | .17 | .47 | .77 |
| 38 | 52 | .12 | .30 | .49 | .70 | .91 | .14 | .39 | .65 | .91 | .20 | .50 | .81 |
| 39 | 51 | .13 | .31 | .50 | .71 | .93 | .16 | .41 | .67 | .93 | .23 | .53 | .84 |
| 40 | 50 | .13 | .32 | .51 | .72 | .94 | .17 | .42 | .68 | .95 | .25 | .55 | .87 |
| 41 | 49 | 1.14 | 1.32 | 1.52 | 1.73 | 1.95 | 2.19 | 2.44 | 2.70 | 2.97 | 3.27 | 3.57 | 3.89 |
| 42 | 48 | .15 | .33 | .52 | .73 | .96 | .20 | .45 | .71 | .98 | .28 | .59 | .90 |
| 43 | 47 | .15 | .33 | .53 | .74 | .97 | .20 | .46 | .72 | 2.99 | .29 | .60 | .92 |
| 44 | 46 | .15 | .33 | .53 | .74 | .97 | .21 | .46 | .73 | 3.00 | .30 | .60 | .92 |
| 45 | 45 | 1.15 | 1.34 | 1.53 | 1.74 | 1.97 | 2.21 | 2.46 | 2.73 | 3.00 | 3.30 | 3.61 | 3.93 |

$R_{in}$ = the correction for inclination of thread.

In our ordinary practice each star is bisected twice on threads at equal hour angles + and —; and $R_{in}$ is thus eliminated.

$R_r$ = the correction for runs.

$R_n$ = the correction for flexure = h sin z.

*Circle West.*

$R_n$ is $\left\{\begin{matrix}\text{positive}\\\text{negative}\end{matrix}\right\}$ for stars $\left\{\begin{matrix}\text{south}\\\text{north}\end{matrix}\right\}$ of the zenith.

*Circle East.*

$R_n$ is $\left\{\begin{matrix}\text{negative}\\\text{positive}\end{matrix}\right\}$ for stars $\left\{\begin{matrix}\text{south}\\\text{north}\end{matrix}\right\}$ of the zenith.

$R_{div}$ = correction for division errors.

$\Delta\Phi$ = the reduction of the latitude from the mercury basin (for reflected stars only) to the centre of the cube of the axis.

$\Delta\Phi$ is $\left\{\begin{matrix}\text{minus}\\\text{plus}\end{matrix}\right\}$ for stars $\left\{\begin{matrix}\text{north}\\\text{south}\end{matrix}\right\}$ of the zenith.

The sum of C and the various R's is $C_o$ = the corrected circle reading.

If $N_e$, $N_w$ is the Nadir-Point, Circle E and Circle W, and $E_e$ and $E_w$, the Equator-Point, Circle East and Circle West; $\Phi$ = the latitude; $\delta$ = a star's declination. Then

*Circle West.*

$$\delta_w = C_o - E_w = C_o - (180° + N_w - \Phi).$$

*Circle East.*

$$\delta_e = E_e - C_o = N_e + \Phi - C_o - 180°.$$

## VI. RESULTS OF INDIVIDUAL OBSERVATIONS WITH THE MERIDIAN CIRCLE FROM 1883 JULY, TO 1883 DECEMBER 31, BY MR. JOHN TATLOCK, JR.

In order to give some data for judging of the perforance of the Meridian Circle, Mr. TATLOCK has collected all those observations of declinations of stars made since July 1883, for which as many as three determinations are available, and they are given in what follows:

The declinations are derived from Nadir observations, and an assumed latitude of +43° 4′ 36″. 64 (U. S. Coast Survey value), using the Pulkova refractions unaltered. It is probable that both the latitude and the refraction will be slightly changed by the series of observations of which these positions form parts. And the positions here given are to be considered only as one part of the study of the performance of the circle, the other parts having been fully set forth in what precedes.

No corrections for flexure or division have been applied.

The positions serve for 1883.0.

*α Andromedae.* R. A = $0^h\ 2^m\ 20^s$.

| Date. | | |
|---|---|---|
| Nov. 28, 1883 | +28° 26′ | 39.″2 |
| Dec. 4, | | 39. 0 |
| Dec. 5, | | 39. 6 |

*β Ceti.* $0^h\ 37^m\ 43^s$.

| | | |
|---|---|---|
| Nov. 28, | —18° 37′ | 43.″8 |
| Dec. 4, | | 45. 0 |
| Dec. 5, | | 43. 7 |

*γ Cassiopeae.* $0^h\ 49^m\ 39^s$.

| | | |
|---|---|---|
| Dec. 5, | +60° 4′ | 56.″7 |
| Dec. 8, | | 56. 3 |
| Dec. 10, | | 57. 3 |

*α Ursæ Minoris.* 1 $15^m\ 52^s$.

| | | | |
|---|---|---|---|
| Oct. 16, | $+88°$ | 41′ | 6.″1 |
| Oct. 23, | | | 4. 7 |
| Nov. 28, | | | 5. 4 |
| Dec. 4, | | | 6. 0 |
| Dec. 8, | | | 3. 8 |
| Dec. 10, | | | 5. 1 |

*ν Ceti.* $1^h\ 54^m\ 30^s$.

| | | | |
|---|---|---|---|
| Nov. 28, | $-21°$ | 38′ | 42.″8 |
| Dec. 4, | | | 42. 9 |
| Dec. 10, | | | 42. 0 |

*α Ursæ Minoris* S. P. $13^h\ 15^m\ 52^s$.

| Date. | | | |
|---|---|---|---|
| Sept. 25, 1883. | $+88°$ | 41′ | 5″.4 |
| Oct. 16, | | | 5 .4 |
| Oct. 18, | | | 6 .3 |
| Oct. 19, | | | 6 .3 |
| Nov. 1, | | | 6 .2 |
| Dec. 4, | | | 5 .0 |
| Dec. 10, | | | 5 .9 |

*η Ursæ Majoris.* $13^h\ 42^m\ 56^s$.

| | | | |
|---|---|---|---|
| Sept. 25, | $+49°$ | 53′ | 51″.2 |
| Oct. 16, | | | 51 .4 |
| Oct. 18, | | | 52 .9 |

*α Bootis.* $14^h\ 10^m\ 19^s$.

| | | | |
|---|---|---|---|
| Sept. 25, | $+19°$ | 47′ | 29″.9 |
| Oct. 16, | | | 31 .4 |
| Oct. 18, | | | 29 .7 |

*β Ursæ Minoris.* $14^h\ 51^m\ 3^s$.

| | | | |
|---|---|---|---|
| Sept. 25, | $+74°$ | 37′ | 61″.2 |
| Oct. 16, | | | 60 2. |
| Oct. 18, | | | 59 .9 |

*δ Ursæ Minoris.* $18^h\ 10^m\ 4^s$.

| Date. | | |
|---|---|---|
| Oct. 2, 1883, | + 86° 36′ | 35.″7 |
| Oct. 10, | | 36. 7 |
| Oct. 18, | | 36. 9 |

110 *Herculis.* $18^h\ 40^m\ 38^s$.

| | | |
|---|---|---|
| Oct. 3, | + 20° 26′ | 6.″2 |
| Oct. 10, | | 6. 3 |
| Oct. 15, | | 6. 4 |

*o Draconis.* $18^h\ 49^m\ 28^s$.

| | | |
|---|---|---|
| Oct. 10, | + 59° 14′ | 42.″8 |
| Oct. 15, | | 43. 0 |
| Nov. 1, | | 43. 4 |

*λ Aquilæ.* $19^h\ 0^m\ 2^s$

| | | |
|---|---|---|
| Oct. 2, | — 5° 3′ | 25.″4 |
| Oct. 3, | | 26. 3 |
| Oct. 10, | | 25. 0 |

The three stars below depend in both co-ordinates upon the system of publication XIV of the Astronomische Gesellschaft, having been reduced differentially from stars of the Berlin Jahrbuch.

*Lacaille* 8252.

| Date. | R. A. h. | m. | s. | Dec. | | |
|---|---|---|---|---|---|---|
| Sept. 26, | 19 | 47 | 17.36 | —24° | 13′ | 49.″7 |
| Oct. 10, | | | 17.45 | | | 50. 4 |
| Oct. 15, | | | 17.24 | | | 50. 7 |

*Lacaille* 8777.

| | | | | | | |
|---|---|---|---|---|---|---|
| Nov. 1, | 21 | 12 | 59.65 | —26° | 50′ | 0.″7 |
| Nov. 2, | | | 59.70 | | | 3. 9 |
| Nov. 6, | | | 59.48 | | | 3. 6 |

*Lacaille* 9547.

| | | | | | | |
|---|---|---|---|---|---|---|
| Nov. 10, | 23 | 33 | 40.15 | —33° | 22′ | 55.″8 |
| Nov. 17, | | | 40.10 | | | 55. 6 |
| Dec. 14, | | | 39.98 | | | 51. 4 |

## VII. LIST OF ONE HUNDRED AND ELEVEN NEW DOUBLE STARS AND TWO NEBULÆ, ENCOUNTERED IN THE SWEEPS FROM DECEMBER 1881, TO JANUARY 1884.

NOTE: The numbers are in continuation of those in Vol. I., pp. 77–89. These stars have all been discovered with a power of 145; those marked Caroline I. with the six inch telescope at Caroline Island in the South Pacific Ocean.

| No | Name. | R. A. 1880. | | | Decl. 1880. | | p. | s. | Mags. | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | h. | m. | s. | ° | ′ | ° | ″ | | | |
| 61 | $W_1B$, 0 h, 468. | 0 | 28 | 57 | +14 | 13 | 250 | 1 | 9.2 | ..11 | |
| 62 | ..... | 0 | 56 | 5: | — 9 | 30: | 310 | ¼ | 10 | ..10 | |
| 63 | D M, +11°, 355. | 2 | 27 | 53 | +11 | 18 | 280 | 1 | 9.0 | .. 9.5 | |
| 64 | D M, + 1°, 456. | 2 | 39 | 20 | + 1 | 3 | 216 | 5½ | 8.5 | ..12 | |
| 65 | ..... | 3 | 25 | 24 | — 6 | 6 | 2 | 4 | 9 | ..10 | |
| 66 | Ll. 7187..... | 3 | 46 | 48 | — 8 | 51 | 265 | 10 | 8 | ..12 | |
| 67 | Ll. 7249..... | 3 | 48 | 54 | —13 | 4 | 155 | 3 | 8 | .. 9 | |
| 68 | ..... | 3 | 49 | 50 | —17 | 19 | 190 | 4 | 10 | ..11 | |
| 69 | D M+18°, 565 . | 3 | 50 | 53 | +18 | 35 | 195 | 1½ | 10 | ..10.5 | |
| 70 | $W_1B$, 3 h, 996. | 3 | 52 | 11 | — 5 | 15 | 270 | 4 | 8.8 | .. 9.5 | |
| 71 | $W_1B$, 3 h, 1005. | 3 | 52 | 21 | — 9 | 15 | 150 | 3 | 9 | ..12 | |
| 72 | ..... | 3 | 59 | 4 | — 9 | 4 | 210 | 2 | 10 | ..10 | |
| 73 | A O $e_2$, 3901... | 5 | 17 | 20 | —17 | 23 | 50 | 2 | 9 | ..11 | |
| 74 | ..... | 5 | 17 | 58 | —17 | 18 | 50 | 6 | 10 | ..10 | |
| 75 | Berlin charts.. | 5 | 21 | 55 | — 8 | 49 | 90 | 4 | 9 | ..10 | |
| 76 | Berlin charts.. | 5 | 28 | 36 | —14 | 27 | 230 | 1 | 10 | ..10 | |
| 77 | Lam. 35..... | 5 | 39 | 45 | —15 | 13 | 310 | 2 | 10 | ..10.5 | |
| 78 | Berlin charts.. | 5 | 42 | 57 | —12 | 45 | 174 | 1½ | 9 | .. 9 | |
| 79 | ..... | 6 | 14 | 13 | — 5 | 57 | 315 | 2 | 10 | ..12 | |

| No | Name. | R. A. 1880. | Decl. 1880. | p. | s. | Mags. | Remarks. |
|---|---|---|---|---|---|---|---|
| | | h. m. s. | ° ′ | ° | ″ | | |
| 80 | Berlin charts.. | 6 31 41 | —14 9 | 134 | 4 | 9.0.. 9.0 | S. p. a dup. (Howe) 34°, 9° 8..11. |
| 81 | ..... | 6 33 31 | —13 56 | 190 | 4 | 10 ..11.5 | |
| 82 | ..... | 6 45 18 | —11 38 | 245 | 1½ | 9 ..10 | |
| 83 | Berlin charts.. | 6 45 36 | —11 17 | 160 | 1½ | 10 ..10 | |
| 84 | ..... | 6 57 43 | — 8 17 | 40 | 6 | 10 ..10 | |
| 85 | ... ... ..... | 7 7 39 | —19 41 | 210 | 1½ | 10.5..11.5 | |
| 86 | ..... | 7 9 20 | —25 46 | 280 | 3 | 10 ..11 | |
| 87 | ..... | 7 14 58 | —21 39 | 275 | 5 | 9.8.. 9.8 | H. 3950 is near = A O $e_2$ 6604. |
| 88 | A O $e_2$ 6629 ... | 7 15 5 | —22 40 | 270 | 4 | 9.2..11 | |
| 89 | ..... | 7 33 55 | —16 25 | 230 | 3 | 9.5..11 | |
| 90 | A O $e_2$ 7228 ... | 7 35 36 | —16 12 | 290 | 4 | 9.5.. 9.8 | |
| 91 | ..... | 7 36 0 | —20 4 | 225 | 1½ | 9.3..11.5 | |
| 92 | ..... | 7 49 28 | —16 20 | 265 | 2 | 10.5..12 | |
| 93 | ..... | 7 53 40 | —10 8 | 210 | 1 | 10 ..11 | |
| 94 | Ll. 15649 ..... | 7 54 14 | —13 31 | 280 | 3½ | 9.0..11 | |
| 95 | ..... | 8 11 8 | —28 25 | 160 | 3½ | 9.5..10.5 | |
| 96 | ..... | 8 20 39 | —22 19 | 315 | 3½ | 9.4..10.5 | |
| 97 | D M. +14°, 1934 | 8 30 56 | +14 40 | 250 | 3 | 11 ..11 | |
| 98 | A O $e_2$ 9673 ... | 9 18 56 | —23 17 | 175 | 2½ | 9.8..10.5 | |
| 99 | ..... | 9 42 28 | —27 2 | 230 | 2½ | 9.8..11 | |
| 100 | ..... | 10 9 58 | —17 50 | 220 | 2 | 10.2..11.3 | |
| 101 | A O $e_2$ 10498 .. | 10 11 5 | —20 4 | 125 | 1½ | 6.5.. 9 | ? |
| 102 | ..... | 10 14 14 | —20 45 | 170 | 2 | 10.4..11.3 | |
| 103 | Lam. 158..... | 10 14 47 | —15 45 | 325 | 2 | 9.5..10.5 | |
| 104 | ..... | 10 14 50 | —16 7 | 200 | 4 | 10 ..10 | |
| 105 | AO$e_2$, 10588... | 10 18 0 | —19 19 | 120 | 1 | 9? ..10? | Hazy. |
| 106 | Stone 5791..... | 10 28 35 | —54 46 | 250 | 2 | 8.5.. 9 | Caroline I. |

| No | Name. | R. A. 1880 | | | Dec 1880 | | p | s | Mags. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | h. | m. | s. | ° | ′ | ° | ″ | | |
| 107 | ..... | 10 | 29 | 40 | −17 | 19 | 310 | 1 | 10.5..11 | Hazy; mags.? |
| 108 | B. B. vi, 63?... | 10 | 33 | 16 | −16 | 57 | 37 | 1 | 8.4.. 9.1 | |
| 109 | AOe$_2$, 10830... | 10 | 37 | 21 | −20 | 24 | 140 | 2½ | 9.8..10.5 | |
| 110 | AOe$_2$, 10860–1. | 10 | 40 | 1 | −19 | 5 | 270 | 3 | 9 ..10 | |
| 111 | ..... | 10 | 49 | 38 | −17 | 40 | 60 | 10 | 9 ..11.5 | A yellow, B blue. |
| 112 | ..... | 11 | 31 | 28 | −60 | 14 | 350 | 1½ | 8.5.. 9.5 | Caroline I. |
| 113 | Berlin charts.. | 11 | 47 | 45 | −13 | 43 | 260 | 4 | 9.5..10 | |
| 114 | Lac. 4936..... | 11 | 48 | 58 | −55 | 25 | 230 | 2 | 7.5.. 8 | Ditto. |
| 115 | ..... | 11 | 57 | 40 | −57 | 5 | 240 | 1½ | 8.5.. 9.5 | Ditto. |
| 116 | Lac. 5223..... | 12 | 31 | 24 | −55 | 16 | 205 | 1½ | 7.3.. 9.3 | Caroline I. |
| 117 | DM. +8°, 2644.. | 12 | 43 | 4 | + 8 | 18 | 200 | 2 | 9 .. 9 | p = 20° ? |
| 118 | .... ..... | 13 | 1 | 16 | −52 | 5 | 200 | 1½ | 9.5.. 9.5 | Caroline I. |
| 119 | Lac. 5434..... | 13 | 6 | 59 | −62 | 57 | 40 | 1½ | 7.5..10 | Ditto. |
| 120 | Ll. 27090 ..... | 14 | 46 | 46 | + 8 | 16 | 220 | 15 | 7.7..10 | |
| 121 | Stone 8250..... | 15 | 3 | 33 | −51 | 38 | 220 | 3 | 7.5.. 9 | Ditto. |
| 122 | Lam. 1868..... | 15 | 28 | 26 | −10 | 7 | 345 | 2½ | 10.5..11 | |
| 123 | W. M.Zones,255 | 15 | 35 | 56 | −21 | 32 | 135 | 4½ | 9 .. 9.8 | |
| 124 | Lac. 6488..... | 15 | 36 | 11 | −50 | 24 | 210 | 2 | 7 .. 9 | Ditto. |
| 125 | ..... | 15 | 53 | 9 | −20 | 4 | 305 | 6 | 9.2.. 9.5 | |
| 126 | ..... | 15 | 53 | 45 | −20 | 6 | 40 | 3 | 9 ..11 | |
| 127 | ..... | 15 | 58 | 35 | −20 | 10 | 130 | 3 | 8.5..10.7 | |
| 128 | AOe$_2$, 15527... | 16 | 13 | 16 | −18 | 7 | 255 | 4 | 8.7.. 9.7 | |
| 129 | ..... | 16 | 17 | 47 | −18 | 19 | 135 | 5 | 9.2..10.5 | |
| 130 | ..... | 16 | 19 | 31 | −18 | 13 | 190 | 1 | 10.2..10.2 | |
| 131 | Stone 9221..... | 16 | 50 | 15 | −56 | 25 | 125 | 2 | 7.5..10 | Caroline I. |
| 132 | ..... | 17 | 11 | 36 | −23 | 52 | 35 | 5 | 9 ..10 | |
| 133 | AOe$_2$, 16701... | 17 | 16 | 35 | −21 | 36 | 170 | 1 | 8.8.. 9.2 | |
| 134 | AOe$_2$, 16726... | 17 | 17 | 42 | −21 | 20 | 155 | 8 | 6.5..12 | |
| 135 | AOe$_2$, 16764–5. | 17 | 18 | 44 | −19 | 11 | 105 | 3 | 9.0..11.5 | |

| No | Name. | R. A. 1880. | | | Decl. 1880. | | p. | s. | Mags. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | h. | m. | s. | ° | ′ | ° | ″ | | |
| 136 | Lac. 7315..... | 17 | 23 | 16 | −40 | 57 | 95 | 1 | 8.0.. 8.5 | Ditto. |
| 137 | ..... | 17 | 31 | 17 | −19 | 1 | 255 | 1 | 10 ..11 | |
| 138 | $AOe_2$, 17072... | 17 | 34 | 19 | −17 | 54 | 270 | 3 | 9.5..10.5 | |
| 139 | Ll. 32716..... | 17 | 48 | 13 | −11 | 37 | 140 | 6 | 7.5..11 | |
| 140 | ..... | 17 | 53 | 56 | −20 | 47 | 260 | 2½ | 9 ..10 | |
| 141 | $AOe_2$, 17868... | 18 | 7 | 0 | −23 | 42 | 30 | 2 | 9.5..10.5 | |
| 142 | Ll. 33492 ..... | 18 | 7 | 58 | −11 | 15 | 225 | 1½ | 10.0..10.5 | |
| 143 | Lam. 549..... | 18 | 10 | 54 | −16 | 54 | 110 | 3 | 10.0..11 | $\beta$ 463? |
| 144 | Y. 7794..... | 18 | 18 | 29 | −21 | 6 | 45 | 7 | 8.8.. 8.8 | |
| 145 | Lam. 667..... | 18 | 35 | 53 | −15 | 30 | 40 | 1 | 10 ..10 | |
| 146 | ..... | 18 | 37 | 27 | −17 | 39 | 230 | 1 | 10 ..10.5 | |
| 147 | $AOe_2$, 18713... | 18 | 42 | 49 | −17 | 2 | 295 | 3 | 9.7..11.5 | Hazy. |
| 148 | $AOe_2$, 18742... | 18 | 43 | 56 | −16 | 54 | 20 | 15 | 9 ..13 | |
| 149 | ..... | 19 | 15 | 16 | −18 | 37 | 185 | 1½ | 10.5..10.5 | |
| 150 | Ll. 36456 ..... | 19 | 15 | 56 | −11 | 51 | 110 | 1½ | 9.8..11.5 | AB. |
| | ..... | ..... | | | ..... | | 150 | 20 | 9.8..12 | AC. |
| 151 | ..... | 19 | 16 | 52 | −18 | 44 | 210 | 2 | 10.8..10.7 | |
| 152 | $AOe_2$, 19672... | 19 | 25 | 4 | −17 | 4 | 190 | 1½ | 9.5..10 | |
| 153 | ..... | 19 | 48 | 58 | −13 | 24 | 120 | 3 | 10 ..11 | |
| 154 | ..... | 19 | 58 | 56 | −14 | 46 | 215 | 2 | 10.5..10.5 | |
| 155 | $W_1$ B, $19^h$, 1463 | 19 | 59 | 43 | −13 | 43 | 270 | 1½ | 8.0.. 9.5 | |
| 156 | Lam. 7278..... | 20 | 0 | 3 | + 1 | 39 | 255 | 1½ | 9.8..10 | |
| 157 | Lam. 477..... | 20 | 8 | 35 | −24 | 34 | 230 | 3 | 10 ..11 | |
| 158 | Lam. 7462..... | 20 | 15 | 14 | + 2 | 28 | 40 | 2 | 9.5..10 | |
| 159 | ..... | 20 | 23 | 7 | −12 | 41 | 280 | 2 | 11 ..11.5 | |
| 160 | $W_1$B, $20^h$, 612. | 20 | 26 | 10 | −13 | 57 | 185 | 1½ | 9.2.. 9.2 | |
| 161 | Ll. 39532..... | 20 | 26 | 17 | − 9 | 18 | 60 | 2 | 9 ..10.5 | |
| 162 | ..... | 20 | 37 | 33 | −14 | 8 | 140 | 2½ | 11 ..11 | |
| 163 | Ll. 40034..... | 20 | 38 | 17 | − 9 | 42 | 100 | 2 | 9 ..11 | |

| No | Name. | R. A., 1880. | | | Decl. 1880. | | p. | s. | Mags. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | h. | m. | s. | ° | ′ | ° | ″ | | |
| 164 | $W_1B, 20^h$, 988. | 20 | 39 | 58 | —12 | 44 | 120 | 5 | 9 ..11 | |
| 165 | $AOe_2$, 21032... | 20 | 53 | 49 | —18 | 7 | 150 | 4 | 8.3..10.5 | |
| 166 | $AOe_2$, 21387... | 21 | 19 | 39 | —21 | 56 | 60 | 3 | 9 ..12 | |
| 167 | ..... ..... | 21 | 36 | 53 | —14 | 43 | 300 | 3 | 11 ..11.5 | |
| 168 | .. ..... | 21 | 54 | .. | —15 | 20 | 344 | 2½ | 10 ..11 | |
| 169 | $AOe_2$, 22195... | 22 | 24 | 20 | —19 | 48 | 170 | 1½ | 8.5..10 | |
| 170 | W. M. Z. 146.. | 23 | 6 | 24 | —22 | 35 | 290 | 1½ | 9.2..10 | |
| 171 | $W_1$ B, $22^h$, 195 | 23 | 11 | 32 | +16 | 12 | 10 | 3 | 9 ..10 | |

TWO NEW NEBULÆ.

| No. | | R. A. 1860; N. P. D. | Description |
|---|---|---|---|
| 24. | 1882. April 20. May 14. | $12^h\ 30^m\ 56^s$; 87° 44′. | S. F. B M. Stell. N. as before. |
| 25. | 1882. May 14. | $15^h\ 1^m\ 12^s$; 100° 40′. | S. F. Stell. N. n. p. G. C. 4055. |

The following known nebulæ have been seen and identified:

G. C. 156; 185; 418 (extended 45°); 551; 582; 586; 656 (F. Stell. N., exactly s. of a star 10 mag.); 707, (stellar p. F.); 933; 964, (F, N, irr. fig. Ex. n. and s.); 1539; 1559; 1613, (cl. with a central vacuity, which is circular and 2′ in diameter): 1838, (p. B. Ex. 150°, 2′ long; connected with stars 13....14. Nuc. in n. p. end of Neb. 1882, April 6, and April 10, p. B.); 1886; 2023; 2294; 2296; 2341 (double nucleus?); 2944; 2979; 2999; 3005 (not large 3′±;) 3090; (R. A. $12^h\ 28^m\ 0^s$, N. P. D. 89° 27′; F. S. b. M.); 3125; 3166; 3660; 4055, (F. L. 4′ in diameter, probably its R. A. to be corrected by + 3ˢ); 4293; 4333; 4397; 4414; 4510; 4543; 4608; 4628; 4738; (*not* p. s., Ex. 90° b. M., 4′ long, 1½′ wide); 5648, (extended); 5651 (extended 120°); 5652 (D'ARREST says p. B; v. F., June 7, 1882); 5657 (N. P. D. of supplement to G. C. to be corrected by —1°.)

## VIII. OBSERVATIONS OF 119 RED OR COLORED STARS BETWEEN 1881 DECEMBER 26 AND 1883 DECEMBER 31.

N. B.—The numbers are in continuation of the observations printed in Vol. I., page 161. The stars are those met in the sweeps.

| No | Name. | R. A. 1880. | | | Decl. 1880. | | Date. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | h. | m. | s. | ° | ′ | | |
| 85 | B. B. vi, no. 61.... | 0 | 21 | 44 | +15 | 49 | 83.70 | Orange yellow; 7.3; Arg. 9.3. |
| 86 | B 48=T Arietis.... | 2 | 41 | 38 | +17 | 1 | 81.99 | Red; mag. 8.0. Hazy sky. |
| 87 | 54 Arietis..... | 3 | 1 | 33 | +18 | 20 | 81.99 | Fine or. yell.; 7.2. D. M. 6.5 mag. Sky hazy. |
| 88 | W, B. 4.h 488..... | 4 | 24 | 0 | +23 | 5 | 83.91 | 7.5 strong reddish yellow; Bessel 7.8; D. M. 7.4. |
| 89 | ..... | 4 | 59 | 41 | —22 | 3 | 82.10 | Fine red; 9.5 mag. Feb. 7–8. |
| 90 | B. 97=ε Leporis... | 5 | 0 | 22 | —22 | 32 | 82.10 | Flaming yellow; not red. |
| 91 | Ll. 10976..... | 5 | 41 | 17 | + 2 | 52 | 82.04 | Reddish; 7.8 mag. |
| 92 | Ll. 12825..... | 6 | 33 | 47 | —14 | 2 | 82.05 | Or. yell.; 5.8 mag. |
| 93 | ..... ..... | 6 | 47 | 15 | — 4 | 27 | 82.14 | Or. red; 8.7 mag. { Feb. 22. Feb. 24. |
| 94 | B. 157=o′ Can. maj. | 6 | 49 | 9 | —24 | 2 | 82.15 | Brilliant or. red. |
| 95 | ..... | 6 | 57 | 1 | — 8 | 16 | 82.14 | Feb. 22, 7.5 mag; Mar. 13, 8 mag.; reddish star in Cl. M. 50. |
| — | B. 163..... | 6 | 57 | 11 | — 8 | 10 | ..... | I did not see this star 1882 Feb. 22, 24, and Mar. 13. |
| 96 | W, B, 213..... | 7 | 8 | 26 | — 9 | 3 | 82.15 | Red.; mag. 9; Bessel (8). |

| No | Name. | R. A. 1880. | | | Decl. 1880. | | Date. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | h. | m. | s. | ° | ′ | | |
| 97 | A $Oe_2$, 6521..... | 7 | 11 | 36 | —22 | 36 | 82.15 | Arg. mag. is (8) Dup. 300°, 70″, 9.3, 11, A reddish, B, blue; Feb. 24; Mar. 2, and Mar. 10. |
| 98 | B. 178..... | 7 | 23 | 36 | —10 | 5 | 82.15 | Or. red; 7 mag. |
| 99 | h. 3973..... | 7 | 26 | 37 | —20 | 41 | 82.11 | Dup. 40°, 7″, 8.5 —9.5 A. white B. a remarkable dull red. |
| 100 | B. B. vi, 109..... | 7 | 33 | 59 | —16 | 35 | 82.25 | Yellow; 6.5 mag. |
| 101 | ..... | 7 | 34 | 39 | —18 | 46 | 82.19 | Reddish; 8.0 mag. |
| 102 | A. $Oe_2$, 7226..... | 7 | 35 | 32 | —16 | 14 | 82.25 | Dup. 150°, 15″; A. reddish, B. blue. |
| 103 | A. $Oe_2$, 7906..... | 7 | 59 | 25 | —17 | 20 | 82.19 | Or. yell.; 6–7 mag. |
| 104 | B. B. vi, 34..... | 8 | 14 | 54 | —23 | 5 | 82.21 | Or. yellow; 6.5 mag.; Mar. 18—Mar. 27. |
| 105 | B. 202 = $\beta$ 207 = Ll. 17091..... | 8 | 33 | 44 | —19 | 19 | 82.15 | Dup. A. or. red; 6.5 mag; B. blue; 9 mag. |
| 106 | B. 211..... | 8 | 48 | 37 | +17 | 41 | 82.11 | Or. red; 8 mag. |
| 107 | Ll. 18646 ..... | 9 | 22 | 15 | — 9 | 30 | 82.27 | Yellow. |
| 108 | Ll. 18650 ..... | 9 | 22 | 29 | — 9 | 28 | 82.27 | Yellow; Dup. 40°,, 12″, 7.5—10.5. |
| 109 | $W_1B.$, 453 ..... | 9 | 22 | 31 | — 9 | 48 | 82.27 | Or. yell.; mag. 7; Bessel (8). |
| 110 | A O $e_2$9763..... | 9 | 23 | 41 | —20 | 14 | 82.28 | Or. yell.; 6.5 mag. |
| 111 | Ll. 18762 ..... | 9 | 26 | 06 | — 9 | 51 | 82.27 | Or. yell.; 6.5 mag. |
| 112 | Ll. 18996 ..... | 9 | 33 | 55 | —10 | 13 | 82.30 | Reddish yellow; 8 mag. |
| 113 | Ll. 19796 ..... | 10 | 3 | 30 | —12 | 47 | 82.27 | Or. yellow; 7.5 mag. |
| 114 | ..... ..... | 10 | 4 | 44 | —11 | 45 | 82.27 | Yellow; 4–5 mag. |
| 115 | B. B. vi, 5 .... .... | 10 | 5 | 36 | —18 | 22 | 82.30 | Reddish yellow; 6.5 mag. |
| 116 | B. B. vi, 18..... | 10 | 12 | 11 | —20 | 26 | 82.33 | Reddish yellow; (3n) 7.0. |
| 117 | B. 242..... | 10 | 31 | 38 | —12 | 46 | 82.30 | Or. red; mag. 6. |
| 118 | Ll. 20671.. ..... | 10 | 36 | 14 | —13 | 09 | 82.30 | Or. red; 7. mag. |

| No | Name. | R. A. 1880. | | | Decl. 1880. | | Date. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | h. | m. | s. | ° | ′ | | |
| 119 | B. 250—R. Crateris. | 10 | 54 | 39 | —17 | 41 | 82.29 | 9.7 mag; very red; a blue star, 11 mag.; prec. R. 4ˢ.5. |
| | | | | | | | 82.30 | Certainly not above 9.0 mag. |
| 120 | A O $e_2$ 11453 ..... | 11 | 25 | 50 | —23 | 53 | 83.28 | Dull or. red; 8.2 mag. |
| 121 | Lac. 5384..... | 12 | 58 | 28 | —51 | 28 | 83. | Reddish; 7.5 mag. (Caroline I.) Stone's mag. 6. |
| 122 | ..... | 13 | 10 | 24 | —63 | 57 | 83. | Brick red; 7.7 (Caroline I.) |
| 123 | Ll. 24769 ..... | 13 | 15 | 43 | —13 | 47 | 82.35 | Or. yell.; 7 mag. |
| 124 | *M.* Virginis = Ll. 25258..... | 13 | 35 | 19 | — 8 | 06 | 82.35 | Or. yell.; 5.5 mag. |
| 125 | $\theta$ Apodis ..... | 13 | 53 | 41 | —76 | 13 | 83. | Fine or. red; 5. mag. (Caroline I). |
| 126 | B. 344..... | 14 | 59 | 56 | —15 | 47 | 82. | Not "very red," but a fine or. yell.; mag. 6. |
| 127 | ..... | 15 | 37 | 22 | — 1 | 19 | 82.43 | Deep red; 10.3 mag. |
| | | | | | | | 82.44 | Red; 10 mag. |
| 128 | A O $e_2$, 15000..... | 15 | 47 | 49 | —20 | 28 | 82.43 | Or. red; 8–9 mag. |
| | | | | | | | 82.49 | Or. red; 7.8. |
| 129 | A O $e_2$, 15036–7.... | 15 | 49 | 22 | —20 | 25 | 82.43 | Or. red; 8 mag. |
| | | | | | | | 82.49 | Or. red; 7.3 mag. |
| 130 | A O $e_2$, 15053..... | 15 | 49 | 56 | —15 | 29 | 82.45 | Slightly reddish; 8 mag. |
| 131 | A O $e_2$, 15055..... | 15 | 50 | 17 | —15 | 41 | 82.45 | Fine or. yell.; 7 mag. |
| 132 | A O $e_2$, 15982 ..... | 16 | 37 | 15 | —18 | 19 | 82.48 | Orange; 7.2 mag. |
| 133 | Lac., 7152..... | 17 | 4 | 5 | —56 | 44 | 83. | Red; 7.0 mag. Stone's mag. 6.,(Caroline I.) |
| 134 | A O $e_2$, 16779–80... | 17 | 19 | 41 | —21 | 22 | 82.48 | Reddish yellow; 7.5 mag. |
| | | | | | | | 82.49 | Reddish yellow; 7.5 mag. |
| | | | | | | | | A O e. has (6.7) and 7. Moonlight. |
| 135 | B. 410 ..... | 17 | 22 | 39 | —19 | 23 | 82.51 | Very red; 7.5 mag. |

| No | Name. | R. A. 1880. h. | m. | s. | Decl. 1880. ° | ′ | Date. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| 136 | B. B. vi 59..... | 17 | 26 | 31 | —22 | 5 | 82.49 | Reddish; 7.7 mag. |
| | | | | | | | | ARGELANDER gives (8.0) mag. |
| | | | | | | | | W. T. Z. 245, gives (9) mag. |
| | | | | | | | | July 1 and 3; 7.5 mag. |
| 137 | Ll. 32694–5–6..... | 17 | 47 | 27 | —11 | 19 | 82.54 | Strong yell.; 6.7 mag. |
| 138 | Ll. 32870..... | 17 | 51 | 58 | —11 | 51 | 82.58 | Strong reddish; 7.8 mag. |
| 139 | A O $e_2$, 17509 ..... | 17 | 55 | 15 | —22 | 54 | 82.49 | Orange; in trifid neb; 8–9 mag. |
| 140 | Ll. 33012 ..... | 17 | 55 | 38 | —12 | 19 | 82.58 | Strong reddish; 6.8 mag. |
| 141 | A O $e_2$, 17627–8.... | 17 | 59 | 36 | —22 | 3 | 83.61 | Fiery yellow; 7.5 mag. |
| 142 | A O $e_2$, 17658–9.... | 18 | 0 | 27 | —22 | 15 | 83.61 | Yellow, 7.8 mag. |
| 143 | W. M. Z..... | 18 | 0 | 30 | —21 | 52 | 83.61 | Reddish yellow; 7.7 mag. |
| 144 | Ll. 33301..... | 18 | 3 | 3 | —11 | 46 | 82.54 | Red; 7.0 mag. |
| 145 | A O $e_2$, 17741–2... | 18 | 3 | 6 | —26 | 3 | 82.49 | Or. yell. mag. 7.0, Arg. (8) and (7). |
| 146 | Ll. 33334..... | 18 | 4 | 5 | —11 | 3 | 82.54 | Reddish; 7–8 mag. |
| 147 | Ll. 33361..... | 18 | 4 | 46 | —11 | 20 | 82.54 | Reddish 6–7 mag. |
| 148 | ..... | 18 | 5 | 59: | —18 | 58: | 82.54 | Or. red; 9 mag. |
| 149 | ..... | 18 | 6 | 36 | —19 | 16 | 82.54 | Very deep dull red; 8.7 mag. |
| 150 | ..... | 18 | 6 | 44: | —19 | 7: | 82.54 | Red; 8.8 mag. |
| 151 | A O $e_2$, 17871..... | 18 | 7 | 03 | —21 | 45 | 83.61 | Yellow; 6. mag. |
| 152 | A O $e_2$, 17917..... | 18 | 8 | 24 | —18 | 58 | 83.57 | Or. red 7.5 mag. |
| 153 | ..... | 18 | 8 | 31 | —20 | 0 | 83.61 | Good red star; 9.5 |
| 154 | Ll. 33605 ..... | 18 | 10 | 43 | —12 | 46 | 82.58 | Reddish 6.7 mag. |
| 155 | ..... | 18 | 11 | 34 | —13 | 29 | 82.58 | Deep red; 9.2 mag. |
| | | | | | | | 82.61 | Dup. 265°, 40″ 9.2—12. |

| No | Name. | R. A. 1880. | | | Decl. 1880. | | Date. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | h. | m. | s. | ° | ′ | | |
| | | | | | | | 82.63 | 9.5, as before. |
| 156 | Lac. 7638..... | 18 | 12 | 10 | —61 | 33 | 83 | Or. red 6 mag. STONE 5.4 mag. (Caroline I.) |
| 157 | $AOe_2$, 18084..... | 18 | 14 | 8 | —24 | 58 | 82.49 | Or red, 6.5 mag.; Arg. (7). |
| 158 | W. Z..... | 18 | 16 | 59 | —19 | 27 | 83.58 | Yellow, 8.8 mag. |
| 159 | $AOe_2$, 18162–3..... | 18 | 17 | 11 | —19 | 52 | 83.58 | Yellow, 9 mag. Arg. (8) (9). |
| 160 | $AOe_2$, 18165–6–7... | 18 | 17 | 32 | —19 | 48 | 83.58 | Yellowish red, 9 mag. ARG. (7.8) (7) (8). |
| 161 | $AOe_2$, 18250..... | 18 | 20 | 59 | —21 | 19 | 82.52 | Red, 8.9 mag. |
| 162 | $AOe_2$, 18263..... | 18 | 21 | 27 | —19 | 51 | 83.57 | Yellowish red, 8.0 mag. |
| 163 | Lamont 90..... | 18 | 24 | 18 | —21 | 20 | 82.52 | Red, 8.7 mag. |
| 164 | ..... | 18 | 24 | 26 | —17 | 30 | 83.60 | Good red, 10 mag. |
| 165 | B 446..... | 18 | 25 | 53 | —14 | 57 | 82.58 | Fine or. red, 5.8 mag. |
| 166 | $AOe_2$, 18501–2= Lam. 648. | 18 | 32 | 11 | —15 | 09 | 83.58 | Reddish yellow, 9 mag., ARG. (7) (7) LAM. (9). |
| 167 | $AOe_2$, 18577..... | 18 | 35 | 51 | —19 | 24 | 82.54 | Strong reddish; 7.5 mag. |
| | | | | | | | 82.58 | Or. red, 6.5 mag., moonlight. |
| 168 | Ll. 34679..... | 18 | 36 | 51 | —11 | 27 | 83.56 | Strong reddish, mag. 8.5 (?) Ll. gives (7). |
| 169 | Ll. 34753..... | 18 | 38 | 36 | —12 | 43 | 82.61 | Strong reddish, 8.8 mag. |
| 170 | Ll. 34764..... | 18 | 38 | 49 | —12 | 43 | 82.61 | Strong reddish, 8.5 mag. |
| 171 | $AOe_2$, 18676..... | 18 | 41 | 13 | —16 | 54 | 82.63 | Or. yellow, 7.8 mag. |
| 172 | $AOe_2$, 18827..... | 18 | 47 | 59 | —16 | 40 | 82.56 | Reddish, 8.5 ? mag. ARG. has (7). |
| 173 | Ll. 35249–50..... | 18 | 49 | 43 | —11 | 29 | 82.56 | Strong reddish, mag. 8.8. Ll. has (7) and (7.5). |
| 174 | $AOe_2$, 18957–8..... | 18 | 54 | 24 | —22 | 52 | 82.61 | Orange, 6.7 mag. |

| No | Name. | R. A. 1880. | | | Decl. 1880. | | Date. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | h. | m. | s. | ° | ′ | | |
| 175 | AOe$_2$, 18995–6..... | 18 | 56 | 30 | —22 | 53 | 82.61 | Red, 8.2 mag. |
| 176 | B. 483..... | 18 | 58 | 0 | — 5 | 52 | 83.66 | 7 mag., very red. |
| 177 | Ll. 35878..... | 19 | 4 | 09 | —12 | 20 | 82.61 | Mag. 7.0. B. C. says: "variable." |
| 178 | B. 488..... | 19 | 9 | 19 | —17 | 11 | 83.60 | Yellow red, = T *Sagitarii*; mag. 9. |
| 179 | A. Oe$_2$, 19382..... | 19 | 12 | 17 | —16 | 8 | 83.66 | Red 8.5; sky very hazy; ARG. (7) LAM. (7–8). |
| | | | | | | | 83.69 | *Orange* red; 7.5 mag. |
| 180 | B. 505..... | 19 | 27 | 26 | —16 | 38 | 82.61 | *Red;* 7 mag. |
| | | | | | | | 82.63 | *Red;* 7.0 mag. |
| | | | | | | | 83.65 | Very red; 7 mag.; sky hazy. |
| | | | | | | | 83.66 | Very red; 8 mag.; sky hazy. |
| 181 | Ll. 37388..... | 19 | 36 | 17 | —14 | 31 | 83.65 | Yellowish red; 9 mag.; Dup. 9 — — — 12. 60°, 20′. |
| 182 | A. Oe$_2$, 19954–5= Lam. 1003..... | 19 | 40 | 15 | —17 | 22 | 83.60 | Fiery yellow; 7.5 mag. |
| | | | | | | | 83.64 | Reddish yellow ——. ARG. (6.7) (7) LAM. (7). |
| 183 | W$_1$ B., 1106..... | 19 | 45 | 03 | —13 | 20 | 83.65 | Or. red; 7.5 mag.; BESSEL (6–7.) |
| 184 | W$_1$ B., 1819..... | 19 | 54 | 23 | —14 | 16 | 83.65 | Orange; 7 mag.; BESSEL (7). |
| 185 | A. Oe$_2$, 20216–7–8.. | 19 | 58 | 32 | —16 | 42 | 83.65 | Or. yellow; 7 mag.; ARG. (7) (8) (7.8). |
| 186 | D. M. 37°, 3821= W$_2$ B. 258..... | 20 | 7 | 44 | +38 | 0 | 83.97 | 7 mag.; strong red yellow. |
| 187 | A. 545..... | 20 | 10 | 5 | —21 | 41 | 82.67 | 7; very red. |
| | | | | | | | 83.74 | 6.9 mag.; deep dull red. |
| 188 | B. 564=70 Aquilae. | 20 | 30 | 29 | — 2 | 58 | 83.67 | Or. red; 4.5 mag. |
| 189 | Lamont 3912..... | 20 | 33 | 58 | — 3 | 4 | 83.66 | Yellow; 6.5 mag.; LAM. (8–9). |

| No | Name. | R. A. 1880. | | | Decl. 1880. | | Date. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | h. | m. | s. | ° | ′ | | |
| 190 | $W_1$ B., 1004 | 20 | 40 | 50 | — 2 | 56 | 83.66 | Yellow; 7 mag.; Bessel (7). |
| 191 | $W_1$ B., 1069 | 20 | 43 | 07 | — 1 | 0 | 83.66 | Yellow; 7 mag.; Bessel (7); Lam. (6.7). |
| 192 | $W_1$ B., 1269 | 20 | 51 | 03 | + 0 | 1 | 83.66 | Yellow, 6.5 mag.; Bessel (7). |
| 193 | Lam. 8006 | 20 | 57 | 16 | — 2 | 48 | 83.66 | Yellow; 8 Lam. (8.9). |
| 194 | $W_1$ B., 1562 | 21 | 2 | 38 | — 6 | 4 | 83.66 | Yellow; 6.5 mag.; Bessel (7) Lamont (8.9). |
| 195 | $W_1$ B., 65 | 21 | 5 | 38 | — 6 | 18 | 83.66 | Yellow; 7.5 mag.; B. blue 200° 10′—7.5 — — 11. |
| 196 | $W_1$ B., 140 | 21 | 8 | 45 | — 6 | 3 | 83.66 | Yellow; 7.7 mag.; Bessel (7). |
| 197 | Lam. 4245 | 21 | 16 | 37 | — 3 | 3 | 83.66 | Yellow with blue comp.; 9—10.5. |
| 198 | Lam. 8300 | 21 | 20 | 09 | — 2 | 13 | 83.66 | Reddish yell.; 9 mag.. |
| 199 | Lam. 4278 | 21 | 22 | 07 | — 3 | 23 | 83.66 | Yellow; 8 mag. |
| 200 | B. 596 | 21 | 40 | 19 | — 2 | 46 | 83.66 | Very red; 6.7 mag. |
| 201 | $W._1$ B., 1139 | 21 | 50 | 04 | — 5 | 20 | 83.66 | Or. yell.; 8.7 mag. |
| 202 | Lamont 3902 | 22 | 20 | 0 | —14 | 43 | 83.73 | 9 mag.; reddish yellow. |
| 203 | $W._2$ B., 886 | 23 | 42 | 32 | +27 | 42 | 83.70 | Reddish yellow; 8.3 Arg. 7.5; $W_2$ B. 7.5. |

## IX. OCCULTATIONS OF FORTY STARS BY THE MOON (Immersions).

The first twenty-two occultations were observed for comparison with such as might be recorded by the various Transit of Venus observing parties. They comprise all visible at Madison during the period 1882, October 16th to 1883, January 16th. Some of the stars are too small, however, to have been observed with six-inch telescopes. The observers are denoted by their initials, as follows:

E. S. H. = E. S. HOLDEN. Observations made by eye and ear, using a sidereal chronometer, compared (usually before and after) with the standard clock.

G. C. C. = GEORGE C. COMSTOCK; observations as above.

C. M. C. = C. M. CONRADSON, whose two observations of 1882, December 15th. were recorded on the chronograph.

J. T. = JOHN TATLOCK, JR. Observations recorded on the chronograph.

The times are Madison mean times. The aperture employed was 15½ inches. The power was usually 145. The relative positions of stars and the moon's limb were read from a glass scale in the eyepiece, and are true to about 1′.

Those stars not identified are either not in catalogues, or in several cases they are such as were observed just before clouds covered the sky, so that they could not referred to known stars. The magnitudes assigned to stars near the moon are often quite erroneous, my own in particular being nearly one magnitude too bright.

1882, October 16.

1. A star 2′.5 south of moon's center disappeared at $7^h\ 51^m\ 28^s.73$, Madison m. t. The time is uncertain by $\pm 0^s.5$, The moon was very low, and set before any others could be observed. E. S. H., observer.

1882, October 17.

2. A star (about 10 mag.) 5′ south of moon's N. L. disappeared at $5^h\ 50^m\ 5^s.46$. Fair observation. E. S. H., observer.

3. A star 1′ south of moon's N. L., was lost in the moon's glare at $7^h\ 1^m\ 3^s.66$. This is very nearly the true time of immersion. E. S. H., observer.
4. A star (9 mag.) 7′ south of moon's N. L., lost in the moon's glare at $7^h\ 6^m\ 19^s.79$. This is very nearly the true time of immersion. E. S. H., observer.
5. A star (8 mag.) 12′ south of moon's N. L., disappeared at $7^h\ 10^m\ 30^s.21$. Good observation. E. S. H., observer.
6. A star (8 mag.) 10½′ south of moon's N. L.. at $21^h\ 10^m$ sid. t., disappeared at $7^h\ 31^m\ 57^s.98$. Good observation. E. S. H., observer.
7. A star (8.5 mag) A O $e_2$, 17728, disappeared at $7^h\ 43^m\ 19^s.45$. E. S. H., observer.
8. A star south following 7, disappeared at $7^h\ 42^m\ 41^s.92$. Good observation. E. S. H., observer.
9. A star (9 mag.) 1′.5 south of moon's center at $21^h\ 33^m$ sid. t., disappeared at $7^h\ 56^m\ 48^s.10$. Satisfactory observation. E. S. H., observer.

October 18, 1882.

10. Yarnall 8087 disappeared at $6^h\ 30^m\ 53^s.96$. Good observation taken between thick clouds, which prevented the observation of Yarnall 8088. E. S. H., observer.
11. A star (6 mag.) about 10′ ± south of moon's N. L., disappeared at $9^h\ 8^m\ 53.90^s$. The observation taken through thick clouds, and uncertain by about $\pm 0^s.3$. E. S. H., observer.

1882, October 19.

12. A star (9 mag.) about 6′.5 north of the moon's south limb disappeared at $7^h\ 7^m\ 38^s.57$. Good observation. E. S. H., observer.

1882, November 15. Hazy sky.

13. A star (9 mag.) 10′.5 south of moon's N. L., disappeared in the glare at $5^h\ 18^m\ 53^s$. Probably this time is not so much as $1^s$ wrong. E. S. H., observer.
14. A star (9 mag.) 5′.8 south of moon's N. L., disappeared at $5^h\ 27^m\ 52^s.59$. This time uncertain by about $0^s.3$. E. S. H., observer.

15. A star (9 mag.) disappeared 5′ south of moon's N. L., at $5^h\ 42^m\ 16^s.22$ This time is uncertain about $0^s.5$. E. S. H., observer.
16. A star (8.5 mag.) disappeared exactly at moon's north point at $6^h\ 0^m\ 11^s.68$. Good observation. E. S. H., observer.
17. A star (A $Oe_2$ 19912–3–4) disappeared at $6^h\ 22^m\ 42^s.58$. The time is uncertain by $0^s.2$. No more stars could be observed on account of a dense mist. E. S. H., observer.

1882, December 14.

18. A star (9 mag.?) disappeared at $7^h\ 29^m\ 51^s.62$. The star was 3′ south of moon's N. L., and is probably Lamont 3606. E. S. H., observer.
19. A star (8 mag.) = Ll. 41526–7 about 10½′ north of moon's S. L., disappeared at $7^h\ 55^m\ 0^s.09$. Good observation. E. S. H., observer.

1882, December 15.

20. A star (Ll. 43386) disappeared at $7^h\ 35^m\ 56^s.19$. C. M. C., observer.
21. A star (Ll. 43400) disappeared at $8^h\ 46^m\ 9^s.26$. Good observation. C. M. C., observer.

1883, January 13.

22. 22 Piscium disappeared at $8^h\ 36^m\ 52^s.49$. Good observation. E. S. H., observer.

No more occultations could be observed before my departure from Madison on the expedition to observe the total eclipse.

1883, April 11.

23. D M., 19°, 1023, disappeared at $9^h\ 36^m\ 21^s.2$. G. C. C., observer.
24. A star, 10½ mag., about 40° from the N. cusp., disappeared at $9^h\ 37^m\ 9^s.3$. G. C. C., observer.
25. A star, 10 mag., about 40° from the N. cusp., disappeared at $9^h\ 38^m\ 7^s.7$. G. C. C., observer.
26. D M. 19°, 1024, disappeared at $9^h\ 50^m\ 18^s.1$. G. C. C., observer.

27. D M. 18°, 921 (?) disappeared at $10^h\ 2^m\ 26^s.9$. G. C. C., observer.
28. 127 *Tauri*, disappeared at $10^h\ 9^m\ 56^s.1$. G. C. C., observer.

1883. April 13.

29. A star (6 mag.) disappeared at $9^h\ 0^m\ 3^s.3$. G. C. C., observer.
30. D M. 16°, 1506, disappeared at $9^h\ 18^m\ 21^s.0$. G. C. C., observer.
31. 68 *Geminorum* = No. 377 NEWCOMB's standard stars, disappeared at $9^h\ 57^m\ 39^s.1$. G. C. C., observer.

1883, May 11.

32. D M. 14°, 1827, disappeared at $9^h\ 11^m\ 41^s.9$. Observation only moderately good. Star was lost at moon's limb. G. C. C., observer.
33. D M. 14°, 1828, disappeared at $9^h\ 15^m\ 24^s.2$. Good observation. G. C. C., observer.
34. D. M. 14°, 1829, disappeared at $9^h\ 26^m\ 32^s.9$. Good observation. G. C. C. observer.

1883, July 13.

35. Ll. 26702 disappeared at $9^h\ 3^m\ 9^s.3$. G. C. C., observer.
36. Ll. 26706 — 7 disappeared at $9^h\ 19^m\ 32^s.1$. G. G. C., observer.

1883, September 12.

37. A star (probably LAMONT, 1100) 9 mag., disappeared at $8^h\ 8^m\ 55^s.8$. G. C. C., observer.

1883, October 10.

38. $W_1$ B, $20,^h$ 844, disappeared at $8^h\ 42^m\ 44^s.8$. E. S. H., observer.

1883, November 10.

39. 21 Piscium disappeared at $6^h\ 21^m\ 43^s.5$. J. T., observer.
40. $W_2$ B; $23^h$,922? disappeared at $7^h\ 7^m\ 28^s.7$. J. T., observer.

## X.—THE STAR-GAUGES OF SIR WILLIAM HERSCHEL, REDUCED TO 1860.0. FIRST SERIES, (NOS. 1-683.)

In this and the following sections I have collected a series of star-gauges and of counts from the celestial charts of DR. PETERS, HERR PALISA and others, for comparison with a series of star-gauges which have been begun at the Washburn Observatory, with the 15 inch equatorial.

Our gauges are made with the full aperture, and with an eye-piece magnifying 195 diameters which has been fitted with a diaphragm containing a square hole 10′ on each side.

The gauges of SIR WILLIAM HERSCHEL were made with his twenty foot reflector and with an eye-piece magnifying 157 times, whose circular field had a diameter of 15′ 4″.

Besides the 683 published gauges of HERSCHEL, 405 unpublished gauges are given in Part XI. or 1088 in all.

The gauges of SIR JOHN HERSCHEL with the same instrument are given in the *Results of Astronomical Observations at the Cape of Good Hope.* The celestial charts of DR. PETERS, and his revision and completion of CHACORNAC'S Paris charts (unpublished) were made with the SPENCER equatorial of Hamilton College Observatory, 13½ inches in aperture. PROF. Watson's charts (ms) were made with the FITZ equatorial of 12½ inches aperture, belonging to the Ann Arbor Observatory. HERR PALISA'S charts (ms) were made with the 6 (French) inch equatorial at Pola, and the 12 inch ALVAN CLARK equatorial of Vienna.

Besides these series, I know of only one other published set of observed star-gauges. These are by M. CELORIA, in the publications of the Milan Observatory, No. XIII. It would be of extreme interest to this branch of astronomy if the counts of stars in each square degree of the *Durchmusterung,* which were made at the observatory at Bonn, (See *Bonner Beobachtungen* Bd. V. sec. 3) could be printed.

The present volume contains then,

| | | | |
|---|---|---|---|
| 683 | gauges | by W. HERSCHEL | (published). |
| 405 | " | " " | (unpublished). |
| 500 | " | " C. H. F. PETERS | (published). |
| 983 | " | " C. H. F. PETERS, J. C. WATSON and J. CHACORNAC | (unpublished). |
| 781 | " | " J. PALISA | (unpublished). |
| 3352 | " | all reduced to 1860.0 | |

I am now discussing these various gauges by a graphical process, and they promise to lead to very interesting results, especially when they are supplemented by other star-gauges covering the same ground and made by a larger instrument. If at the same time the total amount of light in each field could be quickly measured by a tolerably accurate photometric process, the data thus derived would be most important. One of the most obvious deductions from a series of star-gauges of a given region by telescopes of different apertures, is the determination of the number of stars of each (nominal) magnitude which exist in the region. For the difference of the counts made by two telescopes which can just see stars of the $m$th and $n$th magnitudes respectively will give the number of stars of the $(m—n)$th magnitude, and so on.

If these differences, $m$-$n$, $n$-$o$, $o$-$p$, etc., be platted separately, the eye can determine whether each group is affected by a clustering power peculiar to itself, or whether the same cause is apparent in the configurations of the various groups. The question of how many nominal magnitudes correspond to stars which really belong to the same system and are at the same distance, appears to be capable of solution by this process; and other cognate questions will have some light thrown upon them.

This first series of the gauges of Sir WILLIAM HERSCHEL was published in the *Philosophical Transactions* for 1785, page 220. The positions were given for 1690.0. These positions have been brought up to 1860 so as to be true to the nearest 1ˢ and 1′. The computation has been made by Mr. COMSTOCK and portions of it in duplicate by myself.

REDUCTION OF STAR-GAUGES.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 1 | 0 10 24 | +12 10 | 9.9 | 10 | |
| 2 | 13 41 | +25 21 | 20.0 | 10 | |
| 3 | 16 39 | +16 44 | 11.3 | 10 | Most of the stars extremely small. |
| 4 | 17 17 | +41 50 | 60.0 | 1 | |
| 5 | 18 28 | —22 20 | 4.1 | 10 | |
| 6 | 21 27 | —22 20 | 3.2 | 10 | |
| 7 | 25 39 | +23 12 | 11.9 | 10 | |
| 8 | 30 23 | —22 21 | 3.9 | 10 | |
| 9 | 3 4 | + 3 46 | 5.9 | 10 | |
| 10 | 37 39 | +44 2 | 60.0 | 1 | |
| 11 | 40 53 | +44 2 | 40.0 | 1 | |
| 12 | 42 32 | +25 24 | 20.4 | 10 | |
| 13 | 43 29 | +34 18 | 20.0 | 1 | |
| 14 | 44 31 | +35 18 | 24.0 | 1 | |
| 15 | 45 31 | +14 24 | 11.3 | 10 | |
| 16 | 48 57 | +12 13 | 8.1 | 10 | |
| 17 | 49 51 | +42 13 | 60.0 | ½ | |
| 18 | 53 6 | + 3 46 | 7.6 | 10 | |
| 19 | 55 23 | +21 5 | 11.0 | 10 | |
| 20 | 55 38 | +25 24 | 13.0 | 10 | |
| 21 | 57 56 | +32 9 | 40.0 | 1 | |
| 22 | 0 58 5 | +32 43 | 17.0 | 1 | |
| 23 | 1 2 24 | +23 14 | 9.8 | 10 | A little hazy |
| 24 | 3 19 | +45 18 | 73.0 | 1 | |
| 25 | 1 3 8 | +15 39 | 13.0 | 1 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 26 | 1 4 10 | +17 39 | 14.0 | 1 | |
| 27 | 5 3 | +16 55 | 15.0 | 1 | |
| 28 | 6 9 | —22 22 | 3.8 | 10 | |
| 29 | 8 10 | +16 30 | 14.0 | 1 | |
| 30 | 9 16 | +16 39 | 11.1 | 10 | |
| 31 | 10 11 | +16 50 | 11.2 | 10 | |
| 32 | 9 36 | —20 5 | 5.2 | 10 | Very clear for this altitude. |
| 33 | 12 26 | +38 55 | 28.1 | 10 | Most of the stars very small |
| 34 | 12 6 | —22 23 | 2.8 | 10 | |
| 35 | 12 52 | — 3 58 | 7.5 | 10 | |
| 36 | 13 46 | +25 22 | 11.0 | 10 | |
| 37 | 14 52 | —12 23 | 9.2 | 10 | |
| 38 | 17 20 | +45 31 | 58.0 | 1 | |
| 39 | 21 28 | +32 17 | 20.0 | 1 | |
| 40 | 22 14 | +30 35 | 13.0 | 1 | |
| 41 | 21 40 | — 3 56 | 6.3 | 10 | |
| 42 | 25 43 | +42 14 | 30.0 | 1 | |
| 43 | 28 15 | +42 14 | 58.0 | 1 | |
| 44 | 33 19 | +42 13 | 44.0 | 1 | |
| 45 | 36 53 | +25 11 | 12.9 | 10 | |
| 46 | 40 8 | + 3 45 | 5.8 | 10 | |
| 47 | 40 39 | — 3 58 | 7.3 | 10 | |
| 48 | 41 36 | — 9 16 | 6.4 | 10 | |
| 49 | 42 9 | — 1 43 | 7.1 | 10 | |
| 50 | 44 30 | +30 44 | 17.0 | 1 | |
| 51 | 53 0 | +25 10 | 14.4 | 10 | |
| 52 | 54 45 | +21 8 | 7.1 | 10 | |
| 53 | 1 56 28 | — 9 22 | 4.9 | 10 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 54 | 2 3 34 | +14 22 | 12.1 | 10 | |
| 55 | 8 40 | +28 54 | 15.0 | 10 | |
| 56 | 13 17 | + 3 43 | 6.4 | 10 | |
| 57 | 13 43 | +12 10 | 9.3 | 10 | |
| 58 | 15 44 | — 4 8 | 7.8 | 10 | |
| 59 | 16 58 | + 7 45 | 7.3 | 10 | |
| 60 | 18 24 | — 9 24 | 4.3 | 10 | |
| 61 | 21 10 | +25 3 | 14.8 | 10 | |
| 62 | 24 20 | —20 7 | 4.2 | 10 | |
| 63 | 28 42 | +14 23 | 9.9 | 10 | |
| 64 | 33 15 | +45 15 | 82.0 | 1 | |
| 65 | 33 7 | +30 30 | 14.0 | 1 | |
| 66 | 31 4 | —22 22 | 4.2 | 10 | |
| 67 | 34 13 | +32 16 | 15.0 | 1 | |
| 68 | 35 17 | —24 36 | 3.0 | 10 | Too low for great accuracy. |
| 69 | 38 31 | — 4 11 | 6.0 | 10 | |
| 70 | 40 41 | +14 23 | 13.8 | 10 | |
| 71 | 44 4 | + 3 42 | 5.6 | 10 | |
| 72 | 46 30 | — 4 12 | 6.6 | 10 | |
| 73 | 52 9 | +28 53 | 14.8 | 10 | |
| 74 | 56 58 | +16 39 | 11.1 | 10 | Most of the stars very small |
| 75 | 57 57 | — 2 13 | 9.0 | 10 | |
| 76 | 57 14 | —20 13 | 6.1 | 10 | |
| 77 | 2 58 29 | — 4 14 | 6.8 | 10 | |
| 78 | 3 4 15 | +14 19 | 9.2 | 10 | |
| 79 | 9 4 | + 9 30 | 6.1 | 10 | |
| 80 | 11 9 | +12 3 | 4.1 | 10 | |
| 81 | 3 11 5 | + 9 30 | 5.1 | 10 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 82 | 3 14 10 | +12 2 | 3.5 | 10 | |
| 83 | 18 33 | — 9 24 | 6.8 | 10 | |
| 84 | 21 30 | +31 9 | 7.0 | 5 | In part of the heavens which looks pretty free of stars to the naked eye. |
| 85 | 23 30 | +31 8 | 6.1 | 10 | |
| 86 | 25 30 | +31 8 | 9.4 | 10 | |
| 87 | 32 2 | + 7 35 | 10.3 | 10 | |
| 88 | 31 55 | — 2 13 | 10.1 | 10 | |
| 89 | 41 14 | +43 59 | 55.0 | 1 | About 15 stars generally in the field. |
| 90 | 45 22 | +28 32 | 15.0 | 1 | |
| 91 | 43 22 | — 9 30 | 7.4 | 10 | |
| 92 | 43 25 | —22 30 | 4.9 | 10 | |
| 93 | 54 35 | +44 22 | 54.0 | 1 | |
| 94 | 3 56 25 | — 9 28 | 8.1 | 10 | |
| 95 | 4 4 50 | +16 27 | 11.0 | 10 | |
| 96 | 9 57 | — 2 20 | 13.8 | 10 | |
| 97 | 15 26 | + 7 30 | 13.4 | 10 | |
| 98 | 15 40 | —24 29 | 4.2 | 10 | And many extremely small suspected. |
| 99 | 22 40 | +21 52 | 15.3 | 10 | |
| 100 | 23 51 | —22 20 | 6.2 | 10 | |
| 101 | 33 49 | —22 23 | 8.8 | 10 | |
| 102 | 37 7 | +19 41 | 25.0 | 1 | |
| 103 | 38 40 | +20 21 | 17.0 | 1 | |
| 104 | 39 7 | +20 58 | 30.0 | 1 | |
| 105 | 38 20 | — 9 28 | 9.7 | 10 | |
| 106 | 41 29 | +22 48 | 15.6 | 10 | |
| 107 | 42 33 | +21 19 | 36.0 | 1 | |
| 108 | 4 40 35 | —24 34 | 8.1 | 10 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 109 | 4 51 10 | + 3 51 | 19.9 | 10 | |
| 110 | 5 3 11 | +17 17 | 56.0 | 1 | |
| 111 | 6 53 | + 6 53 | 38.0 | 1 | |
| 112 | 7 48 | + 5 39 | 35.0 | 1 | |
| 113 | 11 22 | +20 51 | 34.0 | 1 | |
| 114 | 12 53 | + 6 44 | 17.7 | 6 | |
| 115 | 20 58 | +20 50 | 74.0 | 1 | |
| 116 | 19 39 | − 6 25 | 24.0 | 1 | |
| 117 | 25 40 | − 6 5 | 8.9 | 8 | |
| 118 | 27 19 | + 9 24 | 30.0 | 1 | Not exactly gauged. |
| 119 | 29 38 | − 2 43 | 19.1 | 10 | |
| 120 | 34 34 | +24 4 | 36.0 | 1 | |
| 121 | 37 12 | +21 16 | 58.0 | 1 | |
| 122 | 35 6 | −20 32 | 17.7 | 10 | |
| 123 | 42 42 | +13 56 | 65.0 | 1 | |
| 124 | 43 33 | +23 40 | 86.0 | 1 | |
| 125 | 40 14 | −24 53 | 13.5 | 10 | |
| 126 | 44 47 | +19 33 | 50.0 | 1 | |
| 127 | 47 12 | +28 5 | 20 to 30 | | Not very exact. |
| 128 | 46 49 | +15 39 | 140.0 | ½ | |
| 129 | 48 49 | +19 57 | 73.0 | 1 | |
| 130 | 51 32 | +23 21 | 60.0 | 1 | |
| 131 | 50 48 | −26 40 | 11.5 | 10 | |
| 132 | 54 38 | + 6 33 | 50.0 | 1 | |
| 133 | 54 42 | −22 31 | 19.3 | 10 | |
| 134 | 59 13 | +28 1 | 30.0 | 1 | Not very exact. |
| 135 | 5 57 15 | − 2 49 | 22.4 | 5 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. h. m. s. | Decl. 1860. ′ ″ | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| 136 | 5 58 22 | + 9 57 | 50.0 | 1 | |
| 137 | 6 0 43 | — 3 12 | 44.0 | 1 | |
| 138 | 1 38 | + 6 32 | 60.0 | 1 | |
| 139 | 2 22 | + 9 56 | 110.0 | 1 | |
| 140 | 3 34 | — 2 55 | 57.0 | 1 | |
| 141 | 6 42 | +19 34 | 73.0 | 1 | |
| 142 | 6 22 | + 9 56 | 60.0 | 1 | |
| 143 | 4 54 | —20 33 | 19.6 | 10 | |
| 144 | 7 38 | + 1 24 | 90.0 | 1 | |
| 145 | 8 38 | + 6 30 | 80.0 | 1 | |
| 146 | 9 18 | + 3 21 | 24.1 | 10 | |
| 147 | 10 22 | + 9 54 | 70.0 | 1 | |
| 148 | 13 22 | + 9 54 | 90.0 | 1 | |
| 149 | 15 21 | +22 41 | 120.0 | ½ | Very unequally scattered. |
| 150 | 14 31 | — 6 18 | 52.0 | 1 | |
| 151 | 15 38 | + 6 28 | 80.0 | 1 | |
| 152 | 15 51 | + 9 53 | 70.0 | 1 | |
| 153 | 15 13 | — 1 47 | 54.0 | 1 | Like many such fields. |
| 154 | 16 51 | +21 34 | 56.0 | 1 | |
| 155 | 18 21 | + 9 52 | 74.0 | 1 | |
| 156 | 16 37 | —23 38 | 26.0 | 1 | |
| 157 | 21 42 | +27 56 | 30–40 | 1 | Between (30–40.) |
| 158 | 20 21 | + 9 52 | 63.0 | 1 | The least number I could find |
| 159 | 18 44 | —22 8 | 33.0 | 1 | |
| 160 | 20 18 | — 0 18 | —— | 1 | |
| 161 | 24 16 | +21 45 | 178.0 | ½ | |
| 162 | 6 23 19 | — 0 19 | 77.0 | 1 | |

REDUCTION OF STAR-GAUGES—Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 163 | 6 28 27 | +27 55 | 50.0 | 1 | |
| 164 | 26 31 | — 6 17 | 38.0 | 1 | Very unequally scattered. |
| 165 | 27 40 | — 4 4 | 72.0 | 1 | |
| 166 | 33 13 | —25 6 | 15.9 | 10 | |
| 167 | 35 39 | — 4 43 | 132.0 | ½ | |
| 168 | 37 34 | +19 30 | 50.0 | 1 | |
| 169 | 38 42 | —25 48 | 40.0 | 1 | |
| 170 | 43 16 | — 2 34 | 94.0 | 1 | |
| 171 | 44 20 | +10 46 | 50.0 | 1 | Generally about fifty stars. |
| 172 | 44 22 | — 5 5 | 62.0 | 1 | Twilight. |
| 173 | 46 56 | +14 45 | 70.0 | 1 | Generally about 70. |
| 174 | 47 14 | — 9 17 | 50.0 | 1 | |
| 175 | 46 50 | —26 53 | 13.3 | 10 | |
| 176 | 52 49 | +10 44 | 67.0 | 1 | |
| 177 | 52 29 | —10 41 | 67.0 | 1 | |
| 178 | 57 57 | + 2 27 | 120.0 | ½ | |
| 179 | 59 0 | +12 17 | 50.0 | 1 | Many fields like this. |
| 180 | 58 16 | — 2 45 | 120.0 | ½ | |
| 181 | 59 16 | — 8 46 | 78.0 | 1 | |
| 182 | 6 58 52 | —26 34 | 48.0 | 1 | |
| 183 | 7 1 49 | +10 42 | 60.0 | 1 | About 60 stars. |
| 184 | 1 14 | — 3 12 | 98.0 | 1 | |
| 185 | 1 26 | —21 24 | 45.0 | 1 | |
| 186 | 5 11 | —10 15 | 34.0 | 1 | |
| 187 | 5 46 | — 9 4 | 83.0 | 1 | |
| 188 | 5 49 | —23 3 | 81.0 | 1 | |
| 189 | 7 9 49 | +10 40 | 70.0 | 1 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 190 | 7 12 34 | — 2 19 | 102.0 | 1 | |
| 191 | 12 35 | — 9 15 | 70.0 | 1 | |
| 192 | 12 27 | —21 27 | 70.0 | 1 | |
| 193 | 15 22 | —22 32 | 62.0 | 1 | |
| 194 | 20 11 | —10 23 | 118.0 | ½ | |
| 195 | 23 49 | — 8 31 | 112.0 | ½ | |
| 196 | 27 35 | — 2 11 | 58.0 | 1 | |
| 197 | 29 23 | +10 41 | 48.0 | 1 | |
| 198 | 32 28 | —21 42 | 168.0 | ¼ | One of the richest fields. |
| 199 | 35 23 | —22 56 | 204.0 | ¼ | A field like the rest. |
| 200 | 40 10 | —25 51 | 86.0 | 1 | |
| 201 | 7 48 22 | —23 51 | 108.0 | ½ | |
| 202 | 8 1 47 | + 2 54 | 28.3 | 10 | |
| 203 | 8 30 | —21 44 | 80.0 | 1 | |
| 204 | 10 21 | —24 0 | 60.0 | 1 | |
| 205 | 14 45 | —10 35 | 40.0 | 1 | |
| 206 | 15 49 | — 9 33 | 45.0 | 1 | |
| 207 | 19 18 | — 9 56 | 24.2 | 10 | |
| 208 | 19 58 | —22 46 | 52.0 | 1 | |
| 209 | 29 33 | —22 3 | 35.0 | 1 | |
| 210 | 38 33 | —22 36 | 33.0 | 1 | |
| 211 | 39 53 | —22 42 | 30.0 | 1 | |
| 212 | 42 33 | —22 53 | 24.0 | 1 | |
| 213 | 42 47 | —21 55 | 20.0 | 1 | |
| 214 | 47 38 | —21 48 | 22.0 | 1 | |
| 215 | 52 32 | —24 0 | 13.0 | 1 | |
| 216 | 8 55 16 | — 2 4 | 20.3 | 10 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 217 | 8 55 37 | −23 1 | 16.2 | 10 | |
| 218 | 9 7 16 | +23 0 | 8.3 | 10 | |
| 219 | 14 15 | − 2 3 | 13.8 | 10 | |
| 220 | 17 34 | −25 59 | 14.0 | 10 | |
| 221 | 27 30 | −23 7 | 15.8 | 10 | |
| 222 | 28 58 | − 9 56 | 11.1 | 10 | |
| 223 | 29 44 | + 1 9 | 11.5 | 10 | |
| 224 | 42 51 | −23 9 | 13.0 | 10 | |
| 225 | 45 44 | −26 3 | 10.1 | 10 | |
| 226 | 46 48 | − 1 9 | 7.9 | 10 | |
| 227 | 51 5 | + 2 57 | 7.7 | 10 | |
| 228 | 9 53 40 | −23 8 | 13.2 | 10 | Strong twilight. |
| 229 | 10 7 53 | −26 6 | 9.1 | 10 | |
| 230 | 25 2 | + 1 1 | 7.2 | 10 | |
| 231 | 28 11 | − 2 6 | 6.5 | 10 | |
| 232 | 33 52 | + 1 0 | 4.9 | 10 | |
| 233 | 10 34 54 | + 7 27 | 5.6 | 7 | |
| 234 | 11 12 53 | + 7 27 | 5.3 | 6 | |
| 235 | 16 17 | − 2 9 | 5.6 | 10 | |
| 236 | 18 26 | −26 19 | 6.5 | 10 | Twilight. |
| 237 | 25 39 | + 7 26 | 3.1 | 8 | |
| 238 | 11 29 18 | − 2 13 | 4.9 | 10 | |
| 239 | 12 2 29 | + 7 24 | 6.0 | 5 | |
| 240 | 13 46 | +10 6 | 2.2 | 13 | |
| 241 | 39 16 | +10 1 | 3.4 | 11 | |
| 242 | 55 26 | + 7 24 | 4.6 | 13 | |
| 243 | 12 56 52 | +10 0 | 3.9 | 13 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 244 | 13 2 39 | −12 40 | 9.3 | 10 | Twilight. |
| 245 | 6 1 | −10 51 | 8.1 | 10 | Pretty strong daylight. |
| 246 | 9 46 | +10 1 | 3.8 | 12 | |
| 247 | 26 26 | −12 39 | 8.6 | 10 | Twilight. |
| 248 | 31 46 | −10 54 | 8.4 | 10 | Some daylight. |
| 249 | 36 58 | −12 38 | 11.3 | 10 | |
| 250 | 39 30 | +13 13 | 5.6 | 1 | Generally 5–6 |
| 251 | 48 1 | −15 19 | 8.5 | 10 | |
| 252 | 13 57 50 | −10 51 | 9.2 | 10 | Strong twilight. |
| 253 | 14 0 32 | −12 35 | 10.0 | 10 | |
| 254 | 3 17 | +30 59 | 7.4 | 10 | Twilight. |
| 255 | 7 6 | −15 17 | 12.3 | 10 | Most very small. |
| 256 | 18 54 | −10 49 | 11.2 | 10 | |
| 257 | 23 30 | −23 51 | 9.7 | 10 | |
| 258 | 24 7 | −12 32 | 8.8 | 10 | All sizes. |
| 259 | 33 12 | + 7 21 | 2.7 | 6 | |
| 260 | 38 53 | −10 50 | 13.3 | 10 | |
| 261 | 37 47 | +23 12 | 8.8 | 10 | |
| 262 | 38 28 | + 8 37 | 3.5 | 13 | |
| 263 | 40 36 | +31 9 | 8.9 | 10 | Chiefly small. |
| 264 | 43 37 | −23 48 | 10.3 | 10 | |
| 265 | 49 11 | −12 28 | 14.0 | 10 | All sizes. |
| 266 | 48 9 | +24 30 | 6.4 | 10 | |
| 267 | 54 5 | −25 37 | 10.3 | 10 | |
| 268 | 59 42 | −23 46 | 12.8 | 10 | |
| 269 | 14 58 20 | +31 8 | 9.2 | 10 | |
| 270 | 15 0 13 | +28 38 | 4.4 | 10 | Struve's aurora. |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 271 | 15 0 41 | +23 4 | 9.0 | 10 | Chiefly large |
| 272 | 3 4 | +24 32 | 6.6 | 10 | Most very small. |
| 273 | 9 10 | −25 34 | 8.8 | 10 | |
| 274 | 10 0 | +26 33 | 8.3 | 10 | |
| 275 | 10 37 | +23 6 | 9.5 | 10 | |
| 276 | 12 1 | +24 34 | 5.0 | 10 | |
| 277 | 18 32 | −23 39 | 14.1 | 10 | |
| 278 | 17 37 | − 3 44 | 9.4 | 12 | |
| 279 | 20 57 | +26 34 | 8.9 | 10 | |
| 280 | 22 40 | +31 6 | 10.0 | 10 | Twilight. |
| 281 | 26 52 | +28 44 | 4.9 | 10 | Aurora bright so as to aff'ct gauge. |
| 282 | 27 59 | +13 32 | 9.5 | 4 | |
| 283 | 29 52 | − 3 41 | 10.9 | 12 | |
| 284 | 34 24 | + 7 32 | 11.0 | 5 | |
| 285 | 38 3 | −10 26 | 13.1 | 10 | |
| 286 | 36 30 | +23 12 | 10.6 | 10 | All sizes. |
| 287 | 36 35 | +31 8 | 8.9 | 10 | Twilight. |
| 288 | 39 57 | +13 35 | 6.0 | 6 | |
| 289 | 43 48 | −22 6 | 12.8 | 10 | |
| 290 | 42 57 | +13 36 | 6.5 | 6 | |
| 291 | 48 58 | +31 14 | 13.1 | 10 | Twilight |
| 292 | 52 23 | −27 28 | 18.6 | 10 | |
| 293 | 53 0 | −24 19 | 32.5 | 2 | Stars too small for the gauge. |
| 294 | 55 23 | − 3 36 | 10.8 | 12 | |
| 295 | 58 42 | −23 31 | 17.1 | 10 | |
| 296 | 55 51 | +26 25 | 12.4 | 10 | |
| 297 | 15 59 51 | −22 2 | 18.1 | 10 | Very low. |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 298 | 16 0 33 | −25 25 | 9.2 | 10 | |
| 299 | 7 26 | −27 25 | 7.2 | 10 | |
| 300 | 6 43 | +31 18 | 12.2 | 10 | |
| 301 | 10 27 | −27 24 | 6.1 | 10 | |
| 302 | 10 28 | −25 25 | 1.6 | 10 | |
| 303 | 13 28 | −25 24 | 2.0 | 10 | |
| 304 | 11 52 | +13 50 | 13.0 | 6 | |
| 305 | 14 27 | −23 33 | 0.5 | 10 | Perfectly clear. |
| 306 | 11 47 | +26 29 | 12.0 | 10 | Most small. |
| 307 | 14 10 | −10 24 | 14.6 | 10 | Moon and twilight. |
| 308 | 16 37 | −23 31 | 0.7 | 10 | Perfectly clear. |
| 309 | 14 26 | +23 18 | 13.3 | 10 | |
| 310 | 18 24 | −25 27 | 3.8 | 6 | |
| 311 | 17 5 | − 3 35 | 12.2 | 12 | |
| 312 | 18 41 | −27 14 | 11.6 | 10 | |
| 313 | 19 28 | −23 30 | 1.1 | 10 | Perfectly clear. |
| 314 | 21 38 | −23 30 | 1.4 | 10 | Perfectly clear |
| 315 | 23 38 | −23 29 | 1.8 | 10 | |
| 316 | 20 29 | +31 11 | 14.2 | 10 | Most small. |
| 317 | 21 41 | +26 28 | 15.1 | 10 | Most small. |
| 318 | 23 46 | + 8 55 | 9.7 | 12 | All sizes. |
| 319 | 27 39 | −23 28 | 4.7 | 10 | |
| 320 | 29 4 | + 7 39 | 13.8 | 6 | |
| 321 | 30 42 | +15 54 | 24.0 | 1 | |
| 322 | 33 39 | −23 27 | 13.6 | 10 | |
| 323 | 33 5 | − 3 32 | 13.6 | 12 | Require attention to be seen. |
| 324 | 16 33 15 | + 8 57 | 14.6 | 13 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 325 | 16 34 51 | +21 15 | 21.6 | 10 | Twilight. |
| 326 | 39 45 | —27 10 | 50.4 | 10 | |
| 327 | 38 45 | + 8 58 | 34.0 | 1 | |
| 328 | 38 22 | +23 24 | 18.4 | 10 | Strong twilight. |
| 329 | 42 41 | —23 25 | 20.3 | 10 | Most small. |
| 330 | 39 24 | +31 15 | 15.6 | 10 | Most small. |
| 331 | 42 37 | +26 33 | 16.5 | 10 | Most small. |
| 332 | 44 43 | — 3 35 | 18.6 | 12 | All sizes. |
| 333 | 45 21 | +23 25 | 20.1 | 10 | Strong twilight. |
| 334 | 48 37 | —18 17 | 19.9 | 10 | Ditto. |
| 335 | 51 6 | —23 33 | 41.1 | 8 | |
| 336 | 16 52 49 | +21 19 | 19.0 | 4 | Hazy. |
| 337 | 17 1 38 | —18 14 | 29.8 | 10 | |
| 338 | 16 59 30 | +23 18 | 16.6 | 10 | Daylight pretty strong |
| 339 | 17 2 33 | +26 37 | 26.6 | 10 | Strong twilight. |
| 340 | 8 0 | +31 35 | 18.8 | 10 | Strong daylight. |
| 341 | 10 28 | +23 20 | 35.0 | 1 | Daylight too strong. |
| 342 | 15 52 | — 8 15 | 13.7 | 10 | More suspected. |
| 343 | 20 5 | —27 7 | 7.6 | 10 | |
| 344 | 16 47 | +21 25 | 32.3 | 10 | |
| 345 | 18 15 | +23 22 | 38.0 | 1 | Daylight pretty strong |
| 346 | 20 15 | +26 28 | 32.8 | 10 | Daylight pretty strong |
| 347 | 27 47 | —21 57 | 15.3 | 10 | Moon and daylight pretty strong. |
| 348 | 35 3 | —18 14 | 23.0 | 10 | |
| 349 | 38 5 | —26 56 | 25.0 | 1 | |
| 350 | 16 35 45 | +21 30 | 42.2 | 5 | Twilight. |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 351 | 17 41 5 | −26 55 | 42.0 | 1 | |
| 352 | 44 5 | −26 55 | 52.0 | 1 | Daylight very strong. |
| 353 | 43 52 | − 8 44 | 18.5 | 10 | Twilight. |
| 354 | 50 27 | −30 5 | 84.0 | 1 | Most large. |
| 355 | 51 8 | −24 57 | 77.0 | 1 | Daylight. |
| 356 | 52 6 | −26 52 | 82.0 | 1 | Daylight. |
| 357 | 53 28 | −15 7 | 80.0 | 1 | Flying clouds. |
| 358 | 54 38 | +28 39 | 25.6 | 5 | Most large. |
| 359 | 56 15 | +33 42 | 27.2 | 10 | Twilight. |
| 360 | 18 0 4 | −18 7 | 59.0 | 1 | Like the rest |
| 361 | 2 4 | −18 7 | 118.0 | 1 | Many such fields. |
| 362 | 18 2 14 | − 8 45 | 7.6 | 10 | |
| 363 | 17 59 12 | +27 46 | 40.0 | 1 | Most large. |
| 364 | 17 59 54 | +21 39 | 54.0 | 1 | Daylight. |
| 365 | 18 5 3 | −18 6 | 232. | ½ | |
| 366 | 5 2 | −16 7 | 112.0 | 1 | Many such. |
| 367 | 5 56 | −22 55 | 112.0 | ½ | |
| 368 | 4 3 | +29 32 | 38.0 | 1 | Most large. |
| 369 | 8 13 | −13 24 | 35.0 | 1 | |
| 370 | 9 29 | −28 57 | 64.0 | 1 | |
| 371 | 9 55 | −32 17 | 17.0 | 1 | |
| 372 | 8 57 | −18 8 | 320.0 | ½ | |
| 373 | 8 59 | −14 24 | 68.0 | 1 | |
| 374 | 11 18 | −32 11 | 27.0 | 1 | |
| 375 | 14 46 | −30 41 | 19.0 | 1 | |
| 376 | 14 34 | − 8 46 | 65. | 1 | |
| 377 | 18 15 21 | − 0 34 | 9.4 | 10 | Too soon for gazing. |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 378 | 18 13 47 | +27 48 | 40.0 | 1 | Most large. |
| 379 | 13 15 | +33 46 | 38.2 | 5 | |
| 380 | 17 13 | —13 23 | 88.0 | 3 | |
| 381 | 21 5 | —30 55 | 20.0 | 1 | |
| 382 | 17 29 | +28 55 | 78.0 | 1 | Chiefly large |
| 383 | 21 28 | —14 3 | 170.0 | ½ | |
| 384 | 23 16 | —14 13 | 238.0 | ½ | |
| 385 | 22 46 | — 3 8 | 20.0 | 7 | |
| 386 | 20 58 | +33 44 | 48.0 | 1 | |
| 387 | 24 20 | — 2 38 | 3.4 | 7 | |
| 388 | 25 44 | — 2 37 | 8.9 | 7 | |
| 389 | 27 32 | — 2 37 | 13.8 | 7 | |
| 390 | 29 9 | —12 29 | 9.5 | 2 | |
| 391 | 29 42 | —13 13 | 19.0 | 1 | |
| 392 | 30 38 | — 2 37 | 25.8 | 6 | |
| 393 | 30 39 | —13 50 | 22.0 | 1 | |
| 394 | 30 57 | — 0 36 | 8.6 | 10 | |
| 395 | 31 7 | —13 30 | 24.0 | 1 | |
| 396 | 28 46 | +27 59 | 48.0 | 1 | Large and small. |
| 397 | 28 15 | +33 50 | 39.6 | 5 | |
| 398 | 31 57 | —14 0 | 14.0 | 1 | |
| 399 | 32 14 | —13 39 | 30.0 | 1 | |
| 400 | 34 31 | —25 4 | 35.0 | 1 | |
| 401 | 34 6 | —19 29 | 35.0 | 1 | |
| 402 | 33 39 | —12 25 | 30.0 | 1 | |
| 403 | 34 4 | — 2 53 | 88.0 | 1 | |
| 404 | 18 34 19 | —13 33 | 25.0 | 1 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 405 | 18 35 9 | —12 28 | 39.0 | 1 | |
| 406 | 35 31 | — 7 56 | 111.0 | 1 | |
| 407 | 35 1 | —13 50 | 60.0 | 1 | |
| 408 | 35 59 | — 7 36 | 250.0 | 1 | |
| 409 | 37 58 | —30 51 | 30.0 | 1 | |
| 410 | 38 50 | —30 37 | 32.0 | 1 | |
| 411 | 37 40 | —12 44 | 13.0 | 1 | Extremely small. |
| 412 | 36 56 | — 1 37 | 39. | 1 | Most small. |
| 413 | 37 59 | —13 2 | 20.0 | 1 | Extremely small. |
| 414 | 39 42 | —32 18 | 12.0 | 1 | |
| 415 | 39 0 | —13 16 | 20.0 | 1 | Extremely small. |
| 416 | 38 59 | — 7 42 | 150.0 | 1 | |
| 417 | 40 48 | —31 31 | 24.0 | 1 | |
| 418 | 36 51 | +32 50 | 62.0 | 1 | |
| 419 | 40 2 | — 2 34 | 13.7 | 7 | |
| 420 | 41 9 | —18 45 | 74.0 | 1 | Twilight. |
| 421 | 40 48 | —13 11 | 112.0 | 1 | All sizes. |
| 422 | 40 30 | — 7 45 | 188.0 | ½ | Many more suspected. |
| 423 | 42 13 | +27 34 | 76.0 | 1 | Large and small. |
| 424 | 42 49 | —31 31 | 19.8 | 10 | |
| 425 | 43 1 | —18 35 | 88.0 | 1 | Twilight. |
| 426 | 42 44 | —13 45 | 146.0 | ½ | |
| 427 | 43 20 | — 8 25 | 130.0 | 1 | |
| 428 | 42 15 | +18 16 | 78.0 | 1 | |
| 429 | 41 34 | +29 28 | 80.0 | 1 | Large and small. |
| 430 | 46 38 | —20 3 | 83.0 | 1 | Twilight. |
| 431 | 18 45 22 | — 1 28 | 176.0 | ½ | |

REDUCTION OF STAR-GAUGES—Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 432 | 18 44 18 | +17 41 | 224.0 | ½ | |
| 433 | 46 29 | — 3 19 | 5.0 | 1 | |
| 434 | 47 39 | —14 4 | 118.0 | ½ | |
| 435 | 48 37 | — 3 42 | 116.0 | ¼ | |
| 436 | 49 20 | — 2 37 | 10.0 | 1 | |
| 437 | 48 57 | +18 22 | 236.0 | ¼ | |
| 438 | 50 10 | — 1 27 | 156.0 | ¼ | |
| 439 | 53 47 | —31 28 | 15.2 | 10 | Very clear. |
| 440 | 50 47 | +18 3 | 368.0 | ¼ | |
| 441 | 54 19 | —29 10 | 21.0 | 1 | |
| 442 | 54 48 | —22 32 | 53.0 | 1 | |
| 443 | 51 10 | +29 37 | 84.0 | 1 | All sizes. |
| 444 | 56 18 | — 1 2 | 328.0 | ¼ | |
| 445 | 58 7 | —20 0 | 83.0 | | |
| 446 | 56 55 | +29 17 | 136.0 | ½ | Many small. |
| 447 | 18 57 25 | +32 47 | 84.0 | 1 | |
| 448 | 19 1 27 | —18 13 | 36.8 | 5 | Strong twilight. |
| 449 | 3 16 | —25 17 | 26.2 | 5 | |
| 450 | 0 24 | +32 56 | 93.0 | 1 | |
| 451 | 2 54 | — 1 0 | 328.0 | ¼ | |
| 452 | 4 33 | —14 9 | 180.0 | ½ | |
| 453 | 5 0 | —18 27 | 80.0 | 1 | |
| 454 | 2 3 | +27 43 | 206.0 | ½ | |
| 455 | 7 54 | — 1 0 | 328.0 | ¼ | |
| 456 | 6 59 | + 7 38 | 40.0 | 1 | Too soon. |
| 457 | 8 31 | +18 35 | 75.0 | 1 | |
| 458 | 19 7 53 | +33 28 | 127.0 | 1 | Moon. |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | | | Decl. 1860. | | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | ° | ′ | | | |
| 459 | 19 | 10 | 12 | +15 | 23 | 204.0 | ¼ | Twilight. |
| 460 | | 12 | 10 | —13 | 0 | 160.0 | ½ | |
| 461 | | 13 | 44 | —31 | 23 | 14.1 | 10 | |
| 462 | | 9 | 49 | +34 | 20 | 146.0 | ½ | Moon. |
| 463 | | 13 | 16 | +29 | 8 | 196.0 | ½ | Many small besides. |
| 464 | | 13 | 55 | +33 | 21 | 130.0 | ½ | Moon. |
| 465 | | 14 | 18 | +32 | 18 | 116.0 | ½ | |
| 466 | | 17 | 27 | — 1 | 51 | 120.0 | ½ | |
| 467 | | 19 | 32 | —18 | 44 | 60.0 | 1 | |
| 468 | | 16 | 1 | +33 | 26 | 130.0 | 1 | Moon. |
| 469 | | 20 | 44 | +14 | 57 | 58.0 | 1 | |
| 470 | | 20 | 28 | +30 | 19 | 256.0 | ¼ | |
| 471 | | 20 | 27 | +30 | 49 | 158.0 | ½ | |
| 472 | | 21 | 35 | +18 | 3 | 60.0 | 1 | |
| 473 | | 20 | 48 | +28 | 57 | 279.0 | ⅛ | Too cr'wded for accuracy. |
| 474 | | 24 | 28 | —13 | 18 | 64.0 | 1 | Changed focus. |
| 475 | | 21 | 54 | +34 | 53 | 160.0 | 1 | Moon. |
| 476 | | 23 | 32 | +29 | 36 | 296.0 | ¼ | |
| 477 | | 24 | 37 | +16 | 56 | 56.0 | 1 | |
| 478 | | 27 | 35 | —17 | 53 | 50.0 | 1 | |
| 479 | | 26 | 20 | +12 | 10 | 196.0 | ¼ | |
| 480 | | 25 | 13 | +28 | 58 | 279.0 | ½ | |
| 481 | | 26 | 16 | +33 | 5 | 180.0 | ½ | |
| 482 | | 29 | 47 | —17 | 53 | 55.0 | 1 | |
| 483 | | 27 | 34 | +28 | 45 | 384.0 | ¼ | |
| 484 | | 29 | 0 | +11 | 33 | 472.0 | ½ | |
| 485 | 19 | 27 | 49 | +35 | 3 | 208.0 | ½ | Moon. |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 486 | 19 29 18 | +27 51 | 320.0 | ¼ | |
| 487 | 30 59 | +33 32 | 224.0 | ¼ | |
| 488 | 34 24 | —14 3 | 36.0 | 1 | |
| 489 | 31 33 | +29 38 | 296.9 | ¼ | |
| 490 | 35 7 | —23 30 | 18.3 | 10 | |
| 491 | 31 30 | +33 12 | 190.0 | ½ | Moon. |
| 492 | 32 17 | +26 3 | 280.0 | ½ | |
| 493 | 32 0 | +30 45 | 340.0 | ½ | |
| 494 | 35 10 | —13 29 | 55.0 | 1 | Too small and too crowded to be certain. |
| 495 | 35 12 | +17 48 | 424.0 | ¼ | |
| 496 | 34 29 | +29 14 | 240.0 | ⅛ | |
| 497 | 37 32 | —13 8 | 45.0 | 1 | |
| 498 | 34 31 | +33 33 | 288.0 | ¼ | |
| 499 | 35 30 | +30 56 | 344.0 | ¼ | |
| 500 | 35 16 | +33 35 | 186.0 | ½ | Moon very bright. |
| 501 | 36 51 | +25 12 | 34.0 | 1 | |
| 502 | 33 20 | +15 49 | 588.0 | ¼ | |
| 503 | 36 51 | +35 29 | 312.0 | ¼ | |
| 504 | 40 24 | —2 12 | 62.2 | 5 | |
| 505 | 42 4 | —19 22 | 23.8 | 10 | |
| 506 | 39 9 | +27 47 | 296.0 | ¼ | |
| 507 | 39 23 | +34 49 | 212.0 | ¼ | |
| 508 | 42 37 | —12 49 | 50.0 | 1 | |
| 509 | 40 1 | +29 15 | 240.0 | ⅛ | |
| 510 | 39 57 | +31 24 | 232.0 | ¼ | |
| 511 | 45 11 | —25 21 | 14.1 | 10 | |
| 512 | 19 42 32 | +27 4 | 256.0 | ¼ | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 513 | 19 42 22 | +35 26 | 384.0 | ¼ | |
| 514 | 46 4 | −12 8 | 68.0 | 1 | |
| 515 | 48 35 | +29 48 | 296.0 | ¼ | |
| 516 | 47 30 | +27 24 | 296.0 | ¼ | |
| 517 | 47 25 | +31 12 | 192.0 | ¼ | |
| 518 | 48 33 | +15 51 | 588.0 | ¼ | |
| 519 | 50 14 | +17 11 | 352.0 | ¼ | |
| 520 | 50 1 | +33 2 | 180.0 | ½ | |
| 521 | 51 0 | +25 58 | 124.0 | ½ | Most large. |
| 522 | 53 34 | +12 27 | 140.0 | ½ | Faint moon |
| 523 | 55 5 | −12 38 | 50.0 | 1 | |
| 524 | 54 1 | +17 12 | 352.0 | ¼ | |
| 525 | 57 9 | −25 18 | 12.8 | 10 | Twilight. |
| 526 | 53 57 | +29 51 | 312.0 | ¼ | |
| 527 | 57 11 | −19 20 | 20 9 | 10 | |
| 528 | 53 56 | +32 48 | 312.0 | ¼ | Very unequally scattered. |
| 529 | 55 38 | +33 13 | 268.0 | ¼ | |
| 530 | 56 18 | +33 35 | 120.0 | ½ | Moon. |
| 531 | 58 55 | − 2 13 | 39.2 | 5 | Most small. |
| 532 | 58 34 | +27 50 | 51.0 | 1 | |
| 533 | 58 53 | +33 12 | 220.0 | ½ | Moon. |
| 534 | 19 59 50 | +29 51 | 80.0 | 1 | |
| 535 | 20 0 31 | +26 47 | 52.0 | ½ | |
| 536 | 0 2 | +35 28 | 306.0 | ¼ | |
| 537 | 4 31 | −31 12 | 7.7 | 10 | |
| 538 | 0 23 | +35 15 | 160.0 | ½ | Moon. |
| 539 | 20 2 12 | +12 24 | 120.0 | ½ | Moon. |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 540 | 20 1 8 | +30 30 | 136.0 | ½ | |
| 541 | 2 7 | +27 47 | 48.0 | 1 | |
| 542 | 3 10 | +28 44 | 112.0 | ½ | |
| 543 | 2 57 | +33 11 | 192.0 | ½ | |
| 544 | 4 20 | +27 54 | 45.0 | 1 | |
| 545 | 4 21 | +31 59 | 104.0 | ½ | |
| 546 | 6 49 | +27 51 | 41.0 | 1 | |
| 547 | 8 24 | +11 26 | 56.0 | 1 | Strong moon. |
| 548 | 6 49 | +35 17 | 184.0 | ½ | Moon. |
| 549 | 7 16 | +29 56 | 80.0 | 1 | Most extremely small. |
| 550 | 11 5 | —25 15 | 12.2 | 10 | Twilight. |
| 551 | 9 44 | +10 55 | 68.0 | 1 | Moon. |
| 552 | 12 0 | +33 56 | 46.0 | 1 | Moon. |
| 553 | 13 9 | +11 34 | 280.0 | ½ | |
| 554 | 16 4 | —16 57 | 22.6 | 10 | |
| 555 | 13 44 | +27 58 | 75.0 | 1 | Very small. |
| 556 | 15 1 | +34 3 | 47.4 | 5 | Moon. |
| 557 | 16 10 | +17 34 | 280.0 | ½ | |
| 558 | 18 18 | —13 7 | 38.0 | 1 | |
| 559 | 18 55 | —19 10 | 24.2 | 5 | |
| 560 | 19 16 | —12 17 | 31.0 | 1 | |
| 561 | 19 6 | +32 17 | 76.0 | ½ | |
| 562 | 25 16 | +14 20 | 184.0 | ½ | Some Twilight. |
| 563 | 29 0 | —25 12 | 10.6 | 10 | Twilight. |
| 564 | 27 59 | +29 6 | 88·0 | 1 | |
| 565 | 30 16 | +19 5 | 104.0 | ½ | Hazy. |
| 566 | 20 29 37 | +34 6 | 66.0 | 1 | Moon. |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 567 | 20 32 23 | −12 53 | 20.0 | 1 | |
| 568 | 34 59 | −25 11 | 9.3 | 10 | Twilight. |
| 569 | 35 22 | −12 52 | 22.8 | 10 | |
| 570 | 33 25 | +23 7 | 248.0 | ¼ | |
| 571 | 34 51 | − 2 10 | 30.8 | 5 | |
| 572 | 36 31 | −19 3 | 16.7 | 10 | Not clear. |
| 573 | 37 20 | −31 5 | 7.7 | 10 | Hazy. |
| 574 | 36 33 | − 5 33 | 39.0 | 1 | Most small. |
| 575 | 44 56 | −25 8 | 9.5 | 10 | Moon. |
| 576 | 42 59 | +29 16 | 142.0 | ½ | |
| 577 | 44 12 | +32 8 | 108.0 | ½ | |
| 578 | 46 36 | − 6 30 | 26.6 | 10 | |
| 579 | 46 50 | − 2 8 | 28.2 | 5 | |
| 580 | 47 9 | +24 0 | 78.0 | ½ | |
| 581 | 47 8 | +34 16 | 192.0 | ¼ | |
| 582 | 48 43 | +22 43 | 108.0 | ½ | |
| 583 | 49 50 | +16 4 | 116.0 | ½ | |
| 584 | 50 10 | +28 23 | 112.0 | ½ | |
| 585 | 50 42 | +20 8 | 76.0 | 1 | |
| 586 | 50 11 | +35 50 | 260.0 | ¼ | Same size. |
| 587 | 52 39 | +20 31 | 80.0 | 1 | |
| 588 | 54 20 | +29 52 | 120.0 | ½ | |
| 589 | 57 50 | − 2 6 | 27.0 | 5 | |
| 590 | 20 56 4 | +33 27 | 248.0 | ¼ | Same size. |
| 591 | 21 0 19 | −12 48 | 17.2 | 3 | |
| 592 | 20 58 59 | +22 9 | 70.0 | 1 | |
| 593 | 21 2 49 | −12 47 | 47.0 | 5 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m s. | ° ′ | | | |
| 594 | 21 3 34 | —17 7 | 10.3 | 10 | |
| 595 | 6 18 | —12 46 | 14.9 | 10 | Most extremely small. |
| 596 | 5 9 | +29 15 | 64.0 | 1 | Twilight. |
| 597 | 7 50 | — 2 4 | 21.4 | 5 | |
| 598 | 10 6 | — 6 3 | 40.0 | 1 | Most small. |
| 599 | 11 3 | +24 2 | 80.0 | ½ | |
| 600 | 11 47 | +17 32 | 55.0 | 1 | |
| 601 | 13 56 | +21 18 | 40.0 | 1 | Hazy. |
| 602 | 16 13 | —12 51 | 11.1 | 10 | |
| 603 | 17 22 | —19 3 | 12.8 | 10 | |
| 604 | 15 29 | +25 44 | 110.0 | ½ | |
| 605 | 16 44 | +29 6 | 75.0 | 1 | Twilight. |
| 606 | 17 29 | +30 3 | 70.0 | 1 | Twilight. |
| 607 | 19 13 | +17 24 | 50.0 | 1 | |
| 608 | 20 39 | — 5 31 | 25.0 | 1 | |
| 609 | 20 49 | — 2 2 | 16.4 | 5 | |
| 610 | 24 37 | —19 13 | 15.3 | 10 | |
| 611 | 23 57 | +31 36 | 76.0 | ½ | |
| 612 | 26 2 | +33 23 | 50.0 | 1 | |
| 613 | 29 16 | — 5 59 | 24.0 | 1 | |
| 614 | 30 26 | —17 5 | 8.1 | 10 | |
| 615 | 30 21 | +14 11 | 30.0 | 5 | |
| 616 | 34 19 | — 2 0 | 8.0 | 5 | |
| 617 | 37 27 | + 7 34 | 21.6 | 5 | |
| 618 | 39 13 | +11 48 | 18.9 | 10 | |
| 619 | 39 25 | +33 32 | 25.0 | 1 | |
| 620 | 21 41 48 | — 1 58 | 15.4 | 5 | Strong twilight. |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | | | Decl. 1860. | | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | ° | ′ | | | |
| 621 | 21 | 43 | 53 | − 6 | 31 | 13.6 | 10 | |
| 622 | | 44 | 21 | +24 | 57 | 42.0 | 1 | |
| 623 | | 46 | 3 | +25 | 8 | 60.0 | 1 | |
| 624 | | 48 | 50 | − 5 | 30 | 18.0 | 1 | |
| 625 | | 49 | 16 | +32 | 5 | 44.0 | 1 | |
| 626 | | 52 | 48 | −19 | 8 | 11.5 | 10 | |
| 627 | | 52 | 33 | +31 | 8 | 52.0 | 1 | |
| 628 | | 55 | 52 | +31 | 18 | 29.0 | 1 | |
| 629 | 21 | 59 | 22 | +31 | 52 | 61.0 | 1 | |
| 630 | 22 | 0 | 51 | − 6 | 29 | 11.5 | 10 | |
| 631 | | 3 | 44 | −19 | 6 | 12.8 | 10 | |
| 632 | | 5 | 24 | +31 | 12 | 60.0 | ½ | |
| 633 | | 6 | 16 | +15 | 42 | 33.0 | 1 | |
| 634 | | 5 | 53 | +31 | 43 | 40.0 | ½ | |
| 635 | | 6 | 16 | +32 | 15 | 32.6 | 5 | |
| 636 | | 6 | 21 | +32 | 29 | 34.0 | 1 | |
| 637 | | 10 | 4 | +29 | 40 | 42.6 | 5 | |
| 638 | | 12 | 12 | −19 | 5 | 7.4 | 10 | |
| 639 | | 12 | 2 | +19 | 2 | 25.1 | 10 | |
| 640 | | 16 | 40 | −19 | 5 | 8.9 | 10 | |
| 641 | | 18 | 44 | +15 | 48 | 26.0 | 1 | |
| 642 | | 20 | 26 | − 6 | 23 | 10.7 | 10 | Twilight. |
| 643 | | 19 | 31 | +25 | 3 | 26.6 | 5 | |
| 644 | | 27 | 25 | − 6 | 22 | 9.1 | 10 | Twilight. |
| 645 | | 29 | 49 | −19 | 6 | 8.3 | 10 | |
| 646 | | 29 | 18 | +11 | 58 | 11.7 | 10 | Moon. |
| 647 | 22 | 36 | 30 | − 4 | 12 | 8.1 | 10 | |

REDUCTION OF STAR-GAUGES—Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 648 | 22 39 46 | —19 5 | 5.0 | 10 | |
| 649 | 39 46 | +16 54 | 17.3 | 10 | |
| 650 | 41 29 | +14 1 | 16.5 | 10 | |
| 651 | 42 39 | +28 57 | 20.1 | 10 | |
| 652 | 44 44 | —19 5 | 7.1 | 10 | |
| 653 | 45 5 | +18 56 | 18.5 | 10 | |
| 654 | 48 12 | + 8 48 | 19.0 | 1 | |
| 655 | 48 13 | +25 5 | 21.3 | 10 | |
| 656 | 51 56 | +30 45 | 26.7 | 10 | Moon (faint). |
| 657 | 53 33 | +10 7 | 13.2 | 10 | |
| 658 | 53 29 | +32 16 | 17.2 | 10 | Moon. |
| 659 | 22 57 9 | +18 57 | 13.4 | 10 | |
| 660 | 23 0 38 | +12 11 | 8.2 | 10 | Moon, |
| 661 | 1 28 | — 4 10 | 8.9 | 10 | |
| 662 | 4 2 | +19 1 | 11.6 | 10 | |
| 663 | 5 13 | +23 2 | 12.1 | 10 | |
| 664 | 6 49 | +12 13 | 9.2 | 10 | Moon. |
| 665 | 9 32 | —22 17 | 4.4 | 10 | |
| 666 | 8 38 | +32 17 | 18.7 | 10 | Moon. |
| 667 | 11 17 | +25 5 | 21.3 | 10 | |
| 668 | 14 34 | —19 3 | 7.3 | 10 | Moon. |
| 669 | 17 38 | — 4 6 | 7.5 | 10 | Most extremely small. |
| 670 | 18 25 | +26 0 | 26.0 | 1 | |
| 671 | 19 58 | +29 8 | 21.1 | 10 | |
| 672 | 21 8 | +19 1 | 11.9 | 10 | |
| 673 | 26 26 | + 9 56 | 9.7 | 10 | |
| 674 | 23 32 28 | +21 8 | 12.1 | 10 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. | Decl. 1860. | No. of Stars. | No. of fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 675 | 23 34 26 | −22 16 | 3.1 | 10 | |
| 676 | 40 35 | +21 5 | 9.5 | 10 | |
| 677 | 41 58 | +11 11 | 10.0 | 1 | |
| 678 | 51 39 | +21 6 | 10.9 | 10 | |
| 679 | 53 18 | +45 33 | 50.0 | 1 | |
| 680 | 55 38 | −22 20 | 4.2 | 10′′ | |
| 681 | 23 55 33 | +25 21 | 15.3 | 10 | |
| 682 | 8 3 | + 3 47 | 5.6 | 10 | |
| 683 | 0 8 38 | − 4 7 | 7.8 | 10 | |

## XI.—THE STAR-GAUGES OF SIR WILLIAM HERSCHEL, REDUCED TO 1860.0. SECOND SERIES.

In the *Philosophical Transactions* for 1817, p. 325, SIR WILLIAM HERSCHEL says that beside the star-gauges printed in *Philosophical Transactions,* 1785, above 400 more have been taken in various parts of the heavens and are not published.

On referring this to LIEUT. COL. JOHN HERSCHEL, R. E., he kindly undertook the search for the unpublished gauges, and I owe to him and to MISS ROSE HERSCHEL a complete copy of a *ms* by MISS CAROLINE HERSCHEL, in which these are given, and also a list in which they are arranged in order of R. A.

The original Ms. by MISS CAROLINE HERSCHEL is prefaced by the following words in her own handwriting.

"The following gages begin with the 358 sweep. As far as 357 sweep, they are printed in the paper on the Construction of the Heavens. and their places have been given in FLAMSTEED'S time and polar distance. But these gages are calculated for the time when the observations were made, though as far as the 438 sweep, the places are down in the journals in FLAMSTEED'S time and P. D. But every gage is calculated twice, and after having been brought to the time of observation carried into this book."

COL. HERSCHEL has been kind enough to extract from the HERSCHEL Mss. at the Royal Astronomical Society's Rooms, the dates of the sweeps with which we are concerned, and they are given below.

## THE DATES OF THE SWEEPS.

| Sweep. | Date. | Sweep. | Date. | Sweep. | Date. |
|---|---|---|---|---|---|
| 358 | Jan. 27, 1785 | 388 | Mar. 13, 1785 | 430 | Sept. 1, 1785 |
| 359 | 28, | 389 | 16, | 431 | 3, |
| 360 | 29, | 390 | Apr. 3, | 438 | 12, |
| 361 | 30, | 391 | 3, | 445 | 28, |
| 362 | 31, | 392 | 3, | 447 | Oct. 1, |
| 363 | 31, | 393 | 6. | 451 | 3, |
| 364 | Feb. 1, | 396 | 11, | 459 | 6, |
| 365 | 4, | 397 | 11, | 460 | 6, |
| 366 | 4, | 399 | 13, | 461 | 8, |
| 367 | 6, | 400 | 14, | 462 | 8, |
| 368 | 7, | 403 | 27, | 465 | 26, |
| 370 | 8, | 405 | May 1, | 466 | 26, |
| 371 | 8, | 407 | 3, | 467 | 27, |
| 372 | 8, | 408 | 3, | 469 | Nov. 7, |
| 373 | 17, | 409 | 5, | 473 | 22, |
| 374 | 28, | 410 | 11, | 474 | 22, |
| 376 | Mar. 1, | 415 | July 17, | 477 | 23, |
| 377 | 4, | 416 | 30, | 478 | 27, |
| 378 | 5, | 417 | 31, | 479 | 28, |
| 379 | 5, | 418 | Aug. 1, | 481 | 29, |
| 380 | 5, | 419 | 6, | 482 | 29, |
| 381 | 6, | 421 | 7, | 485 | Dec. 7, |
| 382 | 10, | 425 | 12, | 486 | 7, |
| 384 | 11, | 426 | 27, | 496 | 28, |
| 385 | 12, | 427 | 30, | 497 | 28, |
| 386 | 13, | 428 | 31, | 498 | 28, |
| 387 | 13, | 429 | 31, | 499 | 30, |

THE DATES OF THE SWEEPS — Continued.

| Sweep. | Date. | Sweep. | Date. | Sweep. | Date. |
|---|---|---|---|---|---|
| 500 | Dec. 30, 1785 | 660 | Dec. 21, | 934 | Mar. 4, 1790 |
| 502 | 30, | 667 | 26, | 959 | Sept. 11, |
| 506 | Jan. 1, 1786 | 668 | 27, | 963 | Oct. 3, |
| 508 | 2, | 681 | Jan. 11, 1787 | 969 | Oct. 9, |
| 511 | 27, | 711 | Mar. 15, | 1014 | May 28, 1791 |
| 523 | Feb. 15, | 712 | 15, | 1022 | Aug. 14, 1792 |
| 526 | 22, | 715 | 17, | 1023 | 19, |
| 529 | 24, | 716 | 18, | 1024 | 22, |
| 558 | Apr. 30, | 720 | 19, | 1027 | Sept. 15, |
| 559 | 30, | 722 | 20, | 1043 | May 12, 1793 |
| 561 | May 1, | 736 | May 15, | 1056 | Oct. 5, |
| 563 | 14, | 762 | Oct. 10, | 1067 | Dec. 10, 1797 |
| 569 | 28, | 765 | 14, | 1070 | 12, |
| 584 | Sept. 14, | 815 | Mar. 9, 1788 | 1077 | Sept. 9, 1798 |
| 594 | 20, | 816 | 9, | 1080 | Oct. 2, |
| 598 | 21, | 820 | 11, | 1082 | 7, |
| 600 | 22, | 858 | Sept. 9, | 1093 | Jan. 21, 1800 |
| 616 | Oct. 18, | 860 | 21, | 1095 | Mar. 15, 1801 |
| 626 | 26, | 862 | 26, | 1111 | Sept. 26, 1802 |
| 641 | Nov. 28, | 866 | 27, | | |

Mr. TATLOCK has brought up the positions to 1860, without reduction from the apparent place to the beginning of the year of observation. That is by assuming the places given to belong to the beginning of the nearest year. The errors thus introduced are hardly greater than the errors of the original positions, and are less than the errors which will be introduced when these observations are discussed by any graphical process.

The following tables contain the original data, as given by Miss CAROLINE HERSCHEL, should a more accurate reduction be reqnired.

| R. A. | N. P. D. | No. Stars. | No. Gauges. | Sweep. | Remarks. |
|---|---|---|---|---|---|
| h. m. s. | ° ′ | | | | |
| 2 51 43 | 95 59 | 7.4 | 10 | 353 | |
| 3 4 43 | 95 59 | 9.8 | 10 | 358 | |
| 3 50 57 | 96 41 | 8.0 | 10 | 359 | Most of them excess. s. and same pr. l., but very few between. |
| 2 54 17 | 61 27 | 16.1 | 10 | 360 | |
| 3 23 17 | 61 27 | 22 | 5 | 360 | |
| 3 30 23 | 62 11 | 33 | 1 | 360 | |
| 3 34 18 | 62 33 | 32 | 1 | 360 | |
| 4 0 43 | 62 27 | 0 | 1 | 360 | |
| 4 2 13 | 61 29 | 12.4 | 10 | 360 | Unequally scattered. |
| 4 4 13 | 61 29 | 11.3 | 4 | 360 | |
| 4 5 57 | 62 25 | 1 | 1 | 360 | |
| 4 22 13 | 61 29 | 18.2 | 5 | 360 | |
| 4 25 13 | 61 29 | 16.8 | 5 | 360 | |
| 4 30 12 | 61 29 | 15.6 | 5 | 360 | |
| 4 37 36 | 61 5 | 39 | 1 | 360 | |
| 5 11 32 | 61 15 | 80 | ½ | 360 | |
| 5 15 12 | 60 56 | 72 | ½ | 360 | |
| 5 41 44 | 61 23 | 120 | ½ | 360 | |
| 5 45 44 | 62 4 | [112 | ½] | 360 | [See journa l] (in pencil). |
| 5 49 14 | 61 54 | 118 | ½ | 360 | |
| 5 50 14 | 62 17 | 116 | ½ | 360 | |
| 5 52 19 | 61 35 | 108 | ½ | 360 | |
| 5 56 19 | 62 42 | 62 | 1 | 360 | Faint moon light |
| 6 47 37 | 62 58 | 36 | 1 | 361 | Innum. too s. |
| 6 49 37 | 63 23 | 92 | ½ | 361 | With s. s. |
| 6 52 37 | 62 54 | 73 | 1 | 361 | Many more suspected. |
| 7 7 37 | 62 52 | 66 | ½ | 361 | |
| 3 37 8 | 101 34 | 7.1 | 10 | 362 | |

ORIGINAL DATA OF SWEEPS — Continued.

| R. A. | N. P. D. | No. Stars. | No. Gauges. | Sweep. | Remarks. |
|---|---|---|---|---|---|
| h. m. s. | ° ′ | | | | |
| 3 50 6 | 101 35 | 8.8 | 10 | 362 | |
| 4 12 6 | 101 35 | 7.3 | 10 | 362 | |
| 4 25 6 | 101 35 | 7.7 | 10 | 362 | |
| 4 34 4 | 101 38 | 8.4 | 10 | 332 | |
| 4 47 4 | 101 38 | 10.7 | 10 | 362 | |
| 4 59 10 | 101 37 | 10.6 | 10 | 362 | |
| 5 7 11 | 101 36 | 13.5 | 10 | 362 | |
| 5 33 53 | 101 37 | 6.3 | 10 | 362 | Unequally scattered. |
| 5 26 47 | 100 33 | 4 | 1 | 362 | See journal. |
| 5 37 41 | 101 9 | 2 | 1 | 362 | |
| 5 38 11 | 102 43 | 20 | 1 | 362 | |
| 5 46 33 | 101 27 | 12.2 | 10 | 362 | |
| 6 9 53 | 37 21 | 21 | 10 | 362 | |
| 6 20 53 | 101 37 | 41.8 | 5 | 362 | |
| 7 8 27 | 101 32 | 37 | 1 | 363 | |
| 7 22 27 | 102 10 | 120 | ½ | 363 | Changeable focus. |
| 7 25 57 | 101 58 | 96 | ½ | 363 | |
| 7 27 27 | 102 14 | 100 | ½ | 363 | |
| 7 33 27 | 102 33 | 46 | 1 | 363 | |
| 7 35 27 | 101 17 | 52 | 1 | 363 | |
| 7 36 57 | 102 2 | 58 | 1 | 363 | |
| 7 45 27 | 102 45 | 47 | 1 | 363 | |
| 7 47 57 | 102 40 | 56 | 1 | 363 | |
| 7 56 27 | 102 3 | 54 | 1 | 363 | |
| 8 12 27 | 101 33 | 38 | 1 | 363 | |
| 8 56 16 | 103 38 | 8.2 | 10 | 364 | |
| 4 59 15 | 103 38 | 12.3 | 10 | 364 | |
| 8 26 4 | 105 53 | 7.9 | 10 | 365 | |

ORIGINAL DATA OF SWEEPS—Continued.

| R. A. | | | N. P. D. | | No. Stars. | No. Gauges. | Sweep. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| h. | m. | s. | ° | ′ | | | | |
| 3 | 53 | 4 | 105 | 48 | 8.9 | 10 | 365 | |
| 4 | 25 | 4 | 105 | 48 | 7.8 | 10 | 365 | |
| 4 | 52 | 17 | 105 | 51 | 12.3 | 10 | 365 | |
| 5 | 18 | 17 | 105 | 51 | 15.8 | 10 | 365 | |
| 5 | 29 | 6 | 105 | 50 | 20.5 | 10 | 365 | |
| 5 | 46 | 6 | 105 | 50 | 25.8 | 5 | 365 | |
| 6 | 11 | 15 | 106 | 54 | 50 | 1 | 365 | |
| 6 | 12 | 15 | 106 | 17 | 54 | ½ | 365 | |
| 6 | 13 | 45 | 106 | 3 | 40 | 1 | 365 | |
| 6 | 13 | 15 | 105 | 42 | 46 | 1 | 365 | |
| 6 | 23 | 15 | 105 | 25 | 75 | 1 | 365 | |
| 6 | 34 | 15 | 105 | 11 | 56 | 1 | 365 | |
| 7 | 14 | 15 | 105 | 5 | 90 | 1 | 366 | |
| 7 | 30 | 15 | 106 | 10 | 184 | ½ | 366 | Many such f. |
| 7 | 32 | 15 | 105 | 6 | 212 | ½ | 366 | |
| 7 | 45 | 15 | 104 | 43 | 120 | ½ | 366 | But a little hazy |
| 7 | 49 | 15 | 106 | 39 | 216 | ½ | 366 | Most s. |
| 8 | 43 | 15 | 105 | 0 | 42 | 1 | 366 | |
| 9 | 44 | 15 | 105 | 49 | 16.0 | 10 | 366 | |
| 4 | 49 | 49 | 108 | 9 | 13.5 | 10 | 367 | |
| 5 | 13 | 30 | 108 | 9 | 16.2 | 10 | 367 | |
| 5 | 47 | 33 | 108 | 9 | 23.8 | 5 | 367 | |
| 6 | 2 | 33 | 108 | 9 | 31.2 | 5 | 367 | |
| 6 | 10 | 58 | 109 | 26 | 52 | 1 | 367 | |
| 6 | 15 | 58 | 106 | 52 | 34 | 1 | 367 | |
| 6 | 16 | 58 | 108 | 45 | 50 | 1 | 367 | |
| 6 | 23 | 30 | 109 | 28 | 32 | 1 | 367 | |
| 6 | 24 | 0 | 109 | 4 | 30 | 1 | 367 | |

ORIGINAL DATA OF SWEEPS—Continued.

| R. A. | | | N. P. D. | | No. Stars. | No. Gauges. | Sweeps. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| h. | m. | s. | ° | ′ | | | | |
| 6 | 24 | 30 | 108 | 42 | 29 | 1 | 367 | |
| 6 | 25 | 0 | 103 | 18 | 32 | 1 | 367 | |
| 6 | 25 | 30 | 107 | 54 | 43 | 1 | 367 | |
| 6 | 26 | 0 | 107 | 31 | 25 | 1 | 367 | |
| 6 | 26 | 30 | 107 | 8 | 40 | 1 | 367 | |
| 6 | 42 | 29 | 109 | 27 | 40 | 1 | 367 | |
| 6 | 42 | 59 | 109 | 3 | 32 | 1 | 367 | |
| 6 | 43 | 20 | 108 | 40 | 41 | 1 | 367 | |
| 6 | 44 | 17 | 108 | 17 | 37 | 1 | 367 | |
| 9 | 32 | 40 | 107 | 58 | 18.0 | 10 | 368 | |
| 10 | 6 | 40 | 107 | 58 | 17.0 | 10 | 368 | |
| 11 | 25 | 41 | 107 | 59 | 8.6 | 10 | 368 | |
| 11 | 36 | 41 | 107 | 59 | 5.9 | 10 | 368 | |
| 12 | 36 | 41 | 107 | 59 | 9.6 | 10 | 368 | |
| 6 | 42 | 6 | 103 | 7 | 100 | ½ | 370 | |
| 6 | 44 | 6 | 103 | 29 | 116 | ½ | 370 | |
| 6 | 58 | 6 | 104 | 18 | 136 | ½ | 370 | |
| 9 | 13 | 59 | 103 | 52 | 19.0 | 5 | 371 | |
| 9 | 35 | 16 | 103 | 51 | 15.8 | 4 | 371 | |
| 10 | 42 | 38 | 104 | 48 | 8 | 1 | 371 | |
| 10 | 59 | 40 | 103 | 53 | 8.9 | 10 | 371 | |
| 11 | 58 | 12 | 103 | 52 | 10.3 | 10 | 372 | |
| 13 | 5 | 34 | 103 | 57 | 8.4 | 10 | 372 | |
| 13 | 26 | 9 | 103 | 53 | 6.9 | 10 | 372 | |
| 13 | 46 | 13 | 103 | 53 | 8.9 | 10 | 372 | |
| 13 | 52 | 13 | 103 | 53 | 10.2 | 10 | 372 | |
| 14 | 3 | 13 | 103 | 53 | 11.6 | 10 | 372 | |
| 14 | 12 | 12 | 103 | 51 | 10.3 | 10 | 372 | |

ORIGINAL DATA OF SWEEPS—Continued.

| R. A. | | | N. P. D. | | No. Stars. | No. Gauges. | Sweeps. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| h. | m. | s. | ° | ′ | | | | |
| 14 | 30 | 12 | 103 | 51 | 11.6 | 10 | 372 | |
| 14 | 46 | 15 | 103 | 53 | 12.7 | 10 | 372 | |
| 15 | 18 | 58 | 64 | 51 | 9.9 | 10 | 373 | |
| 5 | 50 | 38 | 64 | 29 | 152 | ½ | 374 | Of all sizes. |
| 6 | 11 | 36 | 64 | 45 | 104 | ½ | 374 | |
| 6 | 22 | 6 | 65 | 36 | 140 | ½ | 374 | |
| 6 | 39 | 6 | 66 | 3 | 94 | ½ | 374 | |
| 6 | 42 | 22 | 64 | 21 | 96 | ½ | 374 | |
| 7 | 20 | 15 | 66 | 7 | 48 | ½ | 374 | |
| 7 | 20 | 45 | 65 | 39 | 54 | ½ | 374 | |
| 5 | 55 | 36 | 63 | 30 | 100 | ½ | 376 | |
| 6 | 31 | 59 | 97 | 26 | 60 | 1 | 377 | |
| 6 | 38 | 59 | 98 | 35 | 136 | ½ | 377 | |
| 6 | 39 | 29 | 97 | 46 | 136 | ½ | 377 | |
| 6 | 44 | 59 | 98 | 14 | 120 | ½ | 377 | |
| 7 | 0 | 59 | 97 | 31 | 128 | ½ | 377 | |
| 7 | 1 | 59 | 97 | 5 | 184 | ½ | 377 | |
| 7 | 7 | 59 | 96 | 19 | 132 | ½ | 377 | |
| 7 | 16 | 29 | 98 | 5 | 160 | ½ | 377 | |
| 6 | 33 | 13 | 94 | 36 | 216 | ½ | 378 | |
| 9 | 33 | 27 | 95 | 5 | 14.3 | 10 | 379 | |
| 10 | 21 | 28 | 95 | 9 | 9.6 | 10 | 379 | |
| 11 | 3 | 58 | 95 | 9 | 9.6 | 10 | 379 | |
| 11 | 50 | 42 | 95 | 7 | 9.6 | 10 | 379 | |
| 12 | 23 | 42 | 95 | 7 | 7.3 | 10 | 379 | |
| 13 | 31 | 29 | 95 | 38 | 7.6 | 10 | 380 | |
| 14 | 45 | 14 | 95 | 36 | 12.6 | 10 | 380 | |
| 6 | 34 | 14 | 113 | 36 | 40 | 1 | 381 | |

ORIGINAL DATA OF SWEEPS—Continued.

| R. A. | | | N. P. D. | | No. Stars. | No. Gauges. | Sweep. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| h. | m. | s. | ° | ′ | | | | |
| 6 | 37 | 32 | 114 | 27 | 33 | 1 | 381 | |
| 6 | 40 | 14 | 114 | 5 | 46 | 1 | 381 | |
| 6 | 47 | 44 | 113 | 40 | 42 | 1 | 381 | |
| 6 | 50 | 9 | 113 | 47 | 59 | 1 | 381 | |
| 7 | 1 | 45 | 114 | 12 | 46 | 1 | 381 | |
| 7 | 8 | 45 | 115 | 28 | 73 | 1 | 381 | |
| 7 | 12 | 45 | 115 | 30 | 150 | ½ | 381 | Of all sizes. |
| 7 | 23 | 13 | 114 | 40 | 78 | 1 | 381 | |
| 7 | 31 | 43 | 115 | 3 | 184 | ½ | 381 | |
| 7 | 39 | 13 | 114 | 52 | 212 | ½ | 381 | |
| 7 | 42 | 43 | 114 | 35 | 232 | ½ | 381 | |
| 7 | 57 | 41 | 115 | 48 | 200 | ½ | 381 | |
| 8 | 3 | 41 | 114 | 15 | 108 | ½ | 381 | Most s. |
| 8 | 6 | 11 | 115 | 21 | 86 | ½ | 381 | |
| 8 | 14 | 41 | 115 | 16 | 58 | 1 | 381 | |
| 10 | 56 | 7 | 110 | 22 | 9.9 | 10 | 382 | |
| 11 | 12 | 52 | 110 | 22 | 10.5 | 10 | 382 | |
| 12 | 19 | 16 | 110 | 22 | 7.9 | 10 | 382 | |
| 12 | 48 | 5 | 110 | 23 | 8.3 | 11 | 382 | |
| 13 | 45 | 5 | 110 | 23 | 10.3 | 10 | 382 | |
| 14 | 8 | 5 | 110 | 23 | 9.4 | 10 | 382 | |
| 6 | 50 | 36 | 64 | 59 | 44 | 1 | 384 | Faint twilight etc. |
| 7 | 4 | 29 | 62 | 16 | 36 | 1 | 384 | |
| 7 | 54 | 33 | 63 | 5 | 17.8 | 10 | 384 | |
| 8 | 23 | 35 | 63 | 8 | 14.7 | 10 | 384 | |
| 7 | 22 | 29 | 61 | 55 | 32 | 1 | 385 | |
| 7 | 22 | 59 | 61 | 21 | 30 | 1 | 385 | |
| 7 | 23 | 39 | 60 | 49 | 22 | 1 | 385 | |

ORIGINAL DATA OF SWEEPS—Continued.

| R. A. | | | N. P. D. | | No. Stars. | No. Gauges. | Sweep. | Remark. |
|---|---|---|---|---|---|---|---|---|
| h. | m. | s. | ° | ′ | | | | |
| 7 | 39 | 39 | 61 | 44 | 39. | 1 | 385 | |
| 7 | 42 | 39 | 60 | 48 | 23.4 | 5 | 385 | |
| 8 | 53 | 11 | 60 | 44 | 13.8 | 10 | 385 | |
| 9 | 38 | 41 | 60 | 43 | 9.2 | 10 | 385 | |
| 7 | 45 | 20 | 58 | 58 | 25. | 1 | 386 | F. moon light. |
| 9 | 36 | 44 | 58 | 41 | 8.7 | 10 | 386 | |
| 9 | 47 | 39 | 58 | 38 | 8.0 | 10 | 386 | |
| 10 | 11 | 29 | 58 | 38 | 6.6 | 10 | 386 | |
| 10 | 32 | 9 | 58 | 38 | 5.5 | 10 | 386 | |
| 13 | 20 | 54 | 58 | 39 | 7.7 | 10 | 387 | |
| 15 | 25 | 44 | 56 | 43 | 9.2 | 10 | 388 | |
| 15 | 38 | 44 | 50 | 43 | 12.5 | 10 | 388 | |
| 15 | 54 | 20 | 56 | 38 | 12.9 | 10 | 388 | |
| 14 | 7 | 49 | 16 | 19 | 11.6 | 5 | 389 | |
| 15 | 33 | 56 | 16 | 18 | 10.1 | 10 | 389 | |
| 10 | 0 | 26 | 16 | 18 | 15.5 | 10 | 389 | |
| 10 | 11 | 19 | 16 | 4 | 11.2 | 10 | 390 | |
| 10 | 47 | 19 | 16 | 4 | 10.0 | 10 | 390 | |
| 11 | 23 | 19 | 16 | 4 | 11.2 | 10 | 390 | |
| 13 | 32 | 28 | 16 | 6 | 9.3 | 10 | 391 | |
| 15 | 46 | 4 | 14 | 12 | 13.9 | 10 | 392 | |
| 10 | 18 | 28 | 62 | 59 | 8.3 | 10 | 393 | |
| 11 | 16 | 16 | 63 | 0 | 6.6 | 10 | 393 | |
| 11 | 53 | 12 | 62 | 58 | 4.3 | 10 | 393 | |
| 12 | 5 | 12 | 62 | 58 | 5.3 | 10 | 393 | |
| 13 | 9 | 19 | 62 | 59 | 5.3 | 10 | 393 | |
| 13 | 47 | 19 | 62 | 59 | 5.4 | 10 | 393 | |
| 13 | 16 | 43 | 60 | 47 | 5.6 | 10 | 396 | |

ORIGINAL DATA OF SWEEPS—Continued.

| R. A. | | | N. P. D. | | No. Stars. | No. Gauges. | Sweep. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| h. | m. | s. | ° | ′ | | | | |
| 13 | 17 | 43 | 60 | 47 | 6.6 | 10 | 396 | |
| 14 | 55 | 39 | 60 | 46 | 7.0 | 10 | 397 | |
| 13 | 29 | 22 | 67 | 22 | 5.4 | 10 | 399 | |
| 13 | 50 | 23 | 67 | 25 | 5.0 | 10 | 399 | Most of them s. |
| 14 | 5 | 30 | 67 | 22 | 5.8 | 10 | 399 | |
| 14 | 45 | 20 | 67 | 13 | 6.5 | 10 | 399 | |
| 15 | 26 | 47 | 91 | 32 | 7.1 | 10 | 400 | Chiefly s. |
| 15 | 55 | 40 | 91 | 34 | 11.9 | 10 | 400 | Chiefly s. |
| 16 | 0 | 41 | 91 | 33 | 16.2 | 10 | 400 | Of various sizes |
| 13 | 5 | 16 | 69 | 0 | 6.4 | 10 | 403 | |
| 13 | 9 | 16 | 69 | 0 | 4.6 | 10 | 403 | |
| 14 | 44 | 28 | 53 | 11 | 9.0 | 10 | 405 | |
| 14 | 58 | 58 | 53 | 11 | 7.2 | 10 | 405 | |
| 15 | 47 | 6 | 53 | 12 | 9.3 | 10 | 405 | |
| 12 | 48 | 52 | 55 | 15 | 6.4 | 10 | 407 | Most s. and many v. s. suspected. |
| 15 | 26 | 24 | 55 | 12 | 7.0 | 10 | 408 | |
| 16 | 15 | 5 | 87 | 19 | 17.9 | 9 | 409 | |
| 15 | 28 | 41 | 87 | 24 | 15.0 | 10 | 410 | Mr. Aubert. |
| 15 | 35 | 41 | 87 | 24 | 14.2 | 10 | 410 | W. H. |
| 15 | 39 | 41 | 87 | 24 | 14.5 | 10 | 410 | Mr. Aubert. |
| 16 | 22 | 40 | 87 | 23 | 11.8 | 10 | 410 | Mr. Aubert. |
| 20 | 6 | 24 | 67 | 29 | 93 | 1 | 415 | |
| 18 | 54 | 56 | 87 | 29 | 90 | 1 | 416 | |
| 19 | 18 | 21 | 87 | 4 | 150 | 1 | 416 | |
| 20 | 12 | 5 | 88 | 4 | 46 | 1 | 417 | |
| 20 | 13 | 35 | 87 | 4 | 41.4 | 5 | 417 | |
| 19 | 2 | 23 | 118 | 21 | 26.2 | 5 | 418 | |
| 19 | 55 | 24 | 118 | 24 | 10.5 | 10 | 418 | |

ORIGINAL DATA OF SWEEPS—Continued.

| R. A. | | | N. P. D. | | No. Stars. | No. Gauges. | Sweep. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| h. | m. | s. | ° | ′ | | | | |
| 20 | 27 | 21 | 118 | 21 | 10.9 | 10 | 418 | |
| 20 | 42 | 21 | 118 | 21 | 6.9 | 10 | 418 | |
| 21 | 2 | 21 | 118 | 20 | 6.5 | 10 | 418 | |
| 21 | 12 | 13 | 79 | 54 | 28 | 1 | 419 | |
| 19 | 59 | 57 | 84 | 31 | 92 | ½ | 421 | |
| 20 | 16 | 27 | 85 | 2 | 45 | 1 | 421 | |
| 20 | 20 | 57 | 85 | 40 | 67 | 1 | 421 | |
| 20 | 21 | 27 | 85 | 29 | 50 | 1 | 421 | |
| 20 | 22 | 38 | 85 | 5 | 48 | 1 | 421 | |
| 20 | 23 | 40 | 85 | 41 | 52 | 1 | 421 | |
| 20 | 24 | 48 | 84 | 16 | 40 | 1 | 421 | |
| 20 | 25 | 46 | 83 | 52 | 43 | 1 | 421 | |
| 22 | 20 | 3 | 90 | 42 | 9.2 | 1* | 425 | * [Sic in MS.] |
| 22 | 28 | 33 | 90 | 42 | 9.2 | 1* | 425 | * [Sic in MS.] |
| 19 | 15 | 17 | 86 | 59 | 220 | ½ | 42– | [sw. not entered. ? 6, 7, 8, 9.] |
| 19 | 25 | 32 | 86 | 27 | 172 | ½ | 42– | [sw. not entered. ? 6, 7, 8, 9.] |
| 19 | 38 | 32 | 87 | 22 | 144 | ½ | 42– | [sw. not entered. ? 6, 7, 8, 9.] |
| 21 | 1 | 37 | 86 | 41 | 18.2 | 10 | 42– | [sw. not entered. ? 6, 7, 8, 9.] |
| 22 | 12 | 32 | 86 | 42 | 10.7 | 10 | 42– | [sw. not entered. ? 6, 7, 8, 9.] |
| 23 | 17 | 35 | 86 | 41 | 5.0 | 10 | 42– | [sw. not entered. ? 6, 7, 8, 9.] |
| 20 | 19 | 25 | 120 | 29 | 7.2 | 10 | 430 | Very clear and with great attention. |
| 20 | 53 | 25 | 120 | 29 | 4.3 | 10 | 430 | |
| 21 | 30 | 25 | 120 | 29 | 4.5 | 10 | 430 | |
| 22 | 34 | 34 | 120 | 31 | 2.9 | 10 | 430 | |
| 23 | 16 | 23 | 120 | 30 | 2.3 | 10 | 430 | |
| 23 | 37 | 32 | 120 | 30 | 2.4 | 10 | 430 | |
| 0 | 30 | 28 | 120 | 30 | 1.5 | 10 | 430 | |
| 20 | 42 | 15 | 94 | 26 | 18.4 | 5 | 431 | |

ORIGINAL DATA OF SWEEPS — Continued.

| R. A. | | | N. P. D. | | No. Stars. | No. Gauges. | Sweep. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| h. | m. | s. | ° | ′ | | | | |
| 23 | 34 | 40 | 96 | 21 | 3.4 | 10 | 438 | The s. spcc. affected by damp. |
| 23 | 22 | 7 | 110 | 18 | 5.6 | 10 | 445 | |
| 23 | 49 | 7 | 110 | 18 | 5.9 | 10 | 445 | |
| 22 | 31 | 14 | 92 | 20 | 7.8 | 10 | 447 | |
| 22 | 45 | 15 | 92 | 20 | 7.2 | 10 | 447 | |
| 0 | 2 | 19 | 105 | 5 | 6.3 | 10 | 451 | |
| 0 | 13 | 19 | 105 | 5 | 4.7 | 10 | 451 | |
| 2 | 5 | 53 | 105 | 4 | 4.5 | 10 | 451 | |
| 2 | 21 | 5 | 108 | 17 | 4.8 | 10 | 459 | |
| 5 | 41 | 13 | 119 | 0 | 8.1 | 10 | 460 | |
| 22 | 54 | 20 | 88 | 35 | 7.1 | 10 | 461 | |
| 0 | 11 | 17 | 88 | 41 | 5.6 | 10 | 461 | |
| 2 | 19 | 21 | 88 | 38 | 7.5 | 10 | 462 | |
| 21 | 52 | 52 | 115 | 0 | 5.8 | 10 | 465 | |
| 22 | 3 | 52 | 115 | 0 | 5.8 | 10 | 465 | |
| 22 | 35 | 52 | 115 | 2 | 4.9 | 10 | 465 | |
| 22 | 56 | 52 | 115 | 2 | 2.8 | 10 | 465 | |
| 23 | 9 | 52 | 115 | 2 | 3.5 | 10 | 465 | |
| 23 | 49 | 52 | 115 | 2 | 4.0 | 10 | 465 | |
| 0 | 8 | 52 | 115 | 2 | 2.3 | 10 | 465 | |
| 1 | 15 | 52 | 115 | 0 | 3.6 | 10 | 465 | |
| 1 | 34 | 52 | 115 | 0 | 3.6 | 10 | 465 | |
| 3 | 17 | 52 | 117 | 6 | 3.6 | 10 | 466 | |
| 21 | 48 | 47 | 117 | 0 | 6.2 | 10 | 467 | |
| 22 | 39 | 43 | 117 | 2 | 3.3 | 10 | 467 | |
| 23 | 32 | 43 | 117 | 3 | 4.8 | 10 | 467 | |
| 1 | 6 | 43 | 117 | 2 | 2.5 | 10 | 467 | |
| 23 | 34 | 3 | 90 | 37 | 7.2 | 10 | 469 | |

ORIGINAL DATA OF SWEEPS—Continued.

| R. A. | | | N. P. D. | | No. Stars. | No. Guages. | Sweep. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| h. | m. | s. | ° | ′ | | | | |
| 0 | 4 | 13 | 90 | 39 | 5.5 | 10 | 469 | |
| 23 | 24 | 43 | 92 | 30 | 6.3 | 10 | 473 | |
| 1 | 46 | 6 | 96 | 12 | 3.5 | 2 | 474 | |
| 0 | 28 | 24 | 80 | 8 | 7.1 | 10 | 477 | |
| 23 | 2 | 29 | 103 | 17 | 6.1 | 10 | 478 | |
| 23 | 13 | 32 | 103 | 17 | 5.3 | 10 | 478 | |
| 2 | 31 | 16 | 103 | 16 | 6.6 | 10 | 478 | |
| 3 | 13 | 41 | 103 | 16 | 6.0 | 10 | 478 | Most s. |
| 22 | 56 | 21 | 101 | 21 | 6.3 | 10 | 479 | |
| 23 | 47 | 15 | 101 | 21 | 6.0 | 10 | 479 | |
| 1 | 4 | 22 | 101 | 24 | 6.1 | 10 | 479 | |
| 1 | 9 | 50 | 71 | 31 | 11.2 | 10 | 481 | |
| 2 | 12 | 2 | 71 | 29 | 6.9 | 10 | 481 | |
| 4 | 31 | 27 | 71 | 29 | 14.3 | 10 | 482 | |
| 4 | 44 | 43 | 71 | 29 | 22.8 | 5 | 482 | All sizes. |
| 5 | 32 | 21 | 66 | 6 | 66 | 1 | 485 | Many s. s. too s. for the gauge. |
| 6 | 21 | 31 | 63 | 47 | 88 | ½ | 486 | |
| 5 | 48 | 44 | 81 | 42 | 120 | ½ | 496 | |
| 6 | 2 | 52 | 81 | 38 | 136 | ½ | 496 | |
| 6 | 12 | 22 | 81 | 47 | 200 | ½ | 496 | |
| 9 | 2 | 54 | 81 | 17 | 12.3 | 10 | 497 | |
| 11 | 17 | 55 | 81 | 11 | 6.3 | 10 | 498 | |
| 1 | 21 | 40 | 106 | 47 | 6.4 | 10 | 499 | |
| 4 | 41 | 30 | 116 | 40 | 5.5 | 10 | 500 | |
| 5 | 23 | 30 | 116 | 49 | 11.6 | 10 | 500 | |
| 9 | 22 | 29 | 117 | 47 | 14.8 | 10 | 502 | |
| 10 | 17 | 54 | 117 | 48 | 9.9 | 10 | 502 | |
| 6 | 51 | 47 | 90 | 59 | 180 | ½ | 506 | |

ORIGINAL DATA OF SWEEPS—Continued.

| R. A. | | | N. P. D. | | No. Stars. | No. Gauges. | Sweep. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| h. | m. | s. | ° | ′ | | | | |
| 6 | 52 | 37 | 91 | 44 | 192 | ¼ | 506 | |
| 11 | 26 | 5 | 54 | 22 | 5.6 | 10 | 508 | |
| 4 | 35 | 37 | 84 | 32 | 22.6 | 5 | 511 | |
| 16 | 47 | 18 | 22 | 58 | 15.8 | 10 | 523 | |
| 17 | 1 | 2 | 23 | 55 | 18.6 | 5 | 523 | |
| 7 | 6 | 42 | 88 | 48 | 160 | ¼ | 526 | |
| 7 | 25 | 40 | 97 | 54 | 104 | ½ | 529 | |
| 7 | 39 | 30 | 98 | 8 | 92 | ½ | 529 | |
| 7 | 50 | 55 | 97 | 3 | 45 | 1 | 529 | |
| 13 | 10 | 28 | 85 | 53 | 6.8 | 10 | 558 | |
| 13 | 54 | 0 | 85 | 53 | 8.3 | 10 | 558 | |
| 16 | 40 | 35 | 119 | 1 | 27.6 | 10 | 559 | |
| 16 | 41 | 32 | 83 | 59 | 19.1 | 10 | 561 | |
| 15 | 22 | 36 | 89 | 32 | 11.4 | 10 | 560 | |
| 17 | 27 | 13 | ..... | | ..... | ..... | 569 | The stars very unequally scattered. |
| 17 | 27 | 33 | 109 | 47 | 0 | 1 | 569 | |
| 17 | 27 | 53 | 110 | 40 | 34 | 1 | 569 | |
| 19 | 54 | 45 | 79 | 53 | 252 | ¼ | 584 | |
| 20 | 40 | 44 | 54 | 33 | 320 | ¼ | 594 | Besides many too s. to be distinctly seen. |
| 21 | 12 | 46 | 52 | 32 | 272 | ¼ | 598 | Most very s. |
| 20 | 55 | 42 | 52 | 16 | 220 | ¼ | 600 | |
| 21 | 55 | 12 | 66 | 34 | 46 | 1 | 616 | |
| 1 | 2 | 42 | 63 | 25 | 14.8 | 10 | 626 | |
| 2 | 17 | 33 | 63 | 26 | 13.2 | 10 | 626 | |
| 6 | 54 | 35 | 95 | 2 | 232 | ¼ | 641 | |
| 12 | 18 | 51 | 111 | 53 | 5.0 | 10 | 660 | |
| 7 | 25 | 19 | 86 | 11 | 112 | ¼ | 667 | |
| 7 | 26 | 49 | 87 | 33 | 52 | ½ | 667 | |

ORIGINAL DATA OF SWEEPS — Continued.

| R. A. | | | N. P. D. | | No. Stars. | No. Gauges. | Sweep. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| h. | m. | s. | ° | ′ | | | | |
| 7 | 28 | 19 | 86 | 22 | 48 | ½ | 667 | |
| 6 | 4 | 23 | 89 | 22 | 104 | ½ | 668 | But one of the richest places, etc. |
| 6 | 41 | 2 | 88 | 31 | 116 | ½ | 668 | See mem. 8′ after the guage. |
| 3 | 18 | 48 | 75 | 18 | 9.2 | 10 | 681 | |
| 3 | 32 | 18 | 75 | 18 | 7.5 | 10 | 681 | |
| 3 | 47 | 18 | 75 | 18 | 8.7 | 10 | 681 | |
| 3 | 57 | 48 | 75 | 18 | 6.1 | 10 | 681 | |
| 12 | 21 | 18 | 119 | 33 | 9.4 | 10 | 711 | |
| 16 | 7 | 51 | 121 | 35 | 13.6 | 10 | 712 | |
| 15 | 54 | 37 | 50 | 50 | 16.7 | 10 | 716 | |
| 9 | 43 | 0 | 48 | 34 | 10.4 | 10 | 716 | |
| 10 | 32 | 47 | 48 | 33 | 7.0 | 10 | 716 | |
| ..... | | | 74 | 18 | 11.2 | 10 | 720 | Time forgot [to be ent.] betw. 14h 3′ and 15h 15′. |
| 14 | 12 | 43 | 56 | 44 | 10.0 | 10 | 722 | |
| 13 | 45 | 38 | 39 | 19 | 8.4 | 10 | 736 | |
| 22 | 12 | 9 | 12 | 1 | 2.3 | 10 | 762 | Most extr. s. |
| 21 | 48 | 20 | 38 | 4 | 280 | ½ | 765 | See mem. on appearance of the heavens. |
| 21 | 50 | 50 | 38 | 9 | 336 | ½ | 765 | |
| 8 | 54 | 40 | 39 | 49 | 12.6 | 10 | 815 | |
| 12 | 36 | 29 | 39 | 48 | 8.0 | 10 | 815 | |
| 14 | 0 | 44 | 107 | 52 | 10.8 | 10 | 820 | |
| 2 | 17 | 12 | 44 | 38 | 60 | ½ | 858 | |
| 2 | 18 | 12 | 44 | 59 | 72 | ½ | 858 | |
| 2 | 19 | 32 | 44 | 57 | 68 | ½ | 858 | |
| 21 | 28 | 49 | 41 | 4 | 360 | ½ | 860 | But most of them v. s. n. |
| 20 | 52 | 55 | 39 | 49 | 15 | 1 | 862 | These guages show, etc. |
| 20 | 53 | 15 | 38 | 54 | 41 | 1 | 862 | |
| 20 | 54 | 55 | 40 | 20 | 17 | 1 | 862 | |

ORIGINAL DATA OF SWEEPS—Continued.

| R. A. | | | N. P. D. | | No. Stars. | No. Gauges. | Sweep. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| h. | m. | s. | ° | ′ | | | | |
| 20 | 59 | 32 | 43 | 49 | 360 to 400 | ¼ | 866 | |
| 21 | 2 | 32 | 43 | 41 | 280 | ¼ | 866 | |
| 6 | 57 | 29 | 107 | 32 | 100 | ¼ | 934 | |
| 6 | 58 | 54 | 107 | 27 | 128 | ¼ | 934 | All sizes. |
| 8 | 34 | 54 | 105 | 44 | 88 | 1 | 934 | The stars have been gradu'lly reduced to this number, and are still decreasing. |
| 8 | 36 | 22 | 107 | 10 | 43 | 1 | 934 | |
| 8 | 41 | 54 | 107 | 43 | 17 | 1 | 934 | |
| 8 | 43 | 24 | 107 | 24 | 26 | 1 | 934 | |
| 8 | 43 | 54 | 108 | 0 | 15 | 1 | 934 | |
| 8 | 44 | 39 | 107 | 13 | 16 | 1 | 934 | |
| 8 | 47 | 54 | 107 | 42 | 14.2 | 10 | 934 | |
| 8 | 55 | 54 | 107 | 42 | 11.6 | 10 | 934 | |
| 19 | 49 | 56 | 47 | 3 | 240 | ¼ | 959 | With many too small to be counted. |
| 19 | 52 | 56 | 48 | 4 | 264 | ¼ | 959 | |
| 20 | 52 | 52 | 66 | 45 | 184 | ¼ | 963 | |
| 20 | 30 | 58 | 44 | 55 | 172 | ¼ | 969 | |
| 20 | 31 | 58 | 43 | 52 | 232 | ¼ | 969 | |
| 17 | 26 | 58 | 55 | 35 | 41.2 | 5 | 1014 | |
| 21 | 13 | 49 | 82 | 10:: | 40 | 1 | 1022 | |
| 19 | 34 | 5 | 72 | 11 | 360 | ¼ | 1023 | 36,593 stars have been seen in 6′. See mem. |
| 19 | 35 | 23 | 75 | 5 | 600:: | ¼ | 1024 | |
| 19 | 53 | 20 | 74 | 11 | 440 | ¼ | 1024 | |
| 20 | 5 | 20 | 72 | 54 | 360 | ¼ | 1024 | |
| 20 | 16 | 20 | 73 | 5 | 260 | ¼ | 1024 | See the rest of memorandum. |
| 19 | 41 | 54 | 52 | 26 | 480 | ¼ | 1027 | |
| 19 | 45 | 54 | 52 | 29 | 612 | ¼ | 1027 | The whole breadth equally rich. |
| 17 | 37 | 2 | 103 | 11 | 60 | 1 | 1043 | But is one of the richest fields now. |
| 20 | 16 | 48 | 98 | 16 | 80 | ¼ | 1056 | |

ORIGINAL DATA OF SWEEPS — Continued.

| R. A. 1880. | | | N. P. D. | | No. Stars. | No. Gauges. | Sweep. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| h. | m. | s. | ° | ′ | | | | |
| 10 | 36 | 53 | 23 | 40 | 18.2 | 10 | 1036 | |
| 15 | 36 | 0 | 12 | 16 | 14.8 | 10 | 1067 | |
| 14 | 38 | 0 | 13 | 24 | 17.2 | 10 | 1070 | |
| 19 | 46 | 15 | 30 | 23 | 112 | ½ | 1077 | |
| 20 | 40 | 41 | 20 | 34 | 48 | 1 | 1080 | |
| 21 | 20 | 41 | 21 | 47 | 32 | 1 | 1080 | Probably affected by haziness. |
| 0 | 17 | 58 | 15 | 32 | 96 | 1 | 1082 | |
| 5 | 33 | — | 73 | 18 | 120 | 1 | 1093 | |
| 7 | 41 | -- | 108 | 28 | 176 | ½ | 1095 | |
| 8 | 58 | 11 | 9 | 6 | 60—70 | 1 | 1111 | |
| 9 | 50 | 11 | 9 | 8 | 20—30 | 1 | 1111 | |

The table immediately following contains the reduction of these observations to 1860. The numbers in the first column continue those assigned by Sir WILLIAM HERSCHEL to his first series.

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860.0. | | | N. P. D. 1860.0. | | No. Stars. | No. Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | ° | ′ | | | |
| 684 | 0 | 6 | 6 | 104 | 40 | 6.3 | 10 | |
| 685 | | 8 | 0 | 90 | 14 | 5.5 | 10 | |
| 686 | | 12 | 38 | 114 | 37 | 2.3 | 10 | |
| 687 | | 15 | 4 | 88 | 16 | 5.6 | 10 | |
| 688 | | 17 | 5 | 104 | 40 | 4.7 | 10 | |
| 689 | | 21 | 28 | 15 | 12 | 96.0 | 1 | |
| 690 | | 32 | 13 | 79 | 44 | 7.1 | 10 | |
| 691 | 0 | 34 | 8 | 120 | 6 | 1.5 | 10 | |
| 692 | 1 | 6 | 39 | 63 | 2 | 14.8 | 10 | |
| 693 | | 8 | 2 | 101 | 0 | 6.1 | 10 | |
| 694 | | 10 | 16 | 116 | 38 | 2.5 | 10 | |
| 695 | | 13 | 48 | 71 | 7 | 11.2 | 10 | |
| 696 | | 19 | 24 | 114 | 37 | 3.6 | 10 | |
| 697 | | 25 | 17 | 106 | 24 | 6.4 | 10 | |
| 698 | | 38 | 21 | 114 | 37 | 3.6 | 10 | |
| 699 | 1 | 49 | 49 | 95 | 50 | 3.5 | 2 | |
| 700 | 2 | 9 | 26 | 104 | 43 | 4.5 | 10 | |
| 701 | | 16 | 8 | 71 | 8 | 6.9 | 10 | |
| 702 | | 21 | 45 | 44 | 18 | 60.0 | ½ | |
| 703 | | 21 | 43 | 63 | 6 | 13.2 | 10 | |
| 704 | | 22 | 44 | 44 | 39 | 72.0 | ½ | |
| 705 | | 23 | 8 | 88 | 18 | 7.5 | 10 | |
| 706 | | 24 | 5 | 44 | 37 | 68.0 | ½ | |
| 707 | | 24 | 34 | 107 | 57 | 4.8 | 10 | |
| 708 | | 34 | 49 | 102 | 56 | 6.6 | 10 | Most of them excessively small and some pretty large, but very few between. |
| 709 | | 55 | 27 | 95 | 41 | 7.4 | 10 | |
| 710 | 2 | 58 | 45 | 61 | 9 | 16.1 | 10 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860.0. | N. P. D. 1860.0. | No. Stars. | No. Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 711 | 3 8 26 | 95 42 | 9.8 | 10 | |
| 712 | 17 11 | 103 0 | 6.0 | 10 | Mostly small. |
| 713 | 21 1 | 116 50 | 3.6 | 10 | |
| 714 | 23 52 | 75 2 | 9.2 | 10 | |
| 715 | 27 49 | 61 11 | 22 | 5 | |
| 716 | 29 31 | 105 38 | 7.9 | 10 | |
| 717 | 34 55 | 61 56 | 33 | 1 | |
| 718 | 36 23 | 75 3 | 7.5 | 10 | |
| 719 | 38 45 | 62 18 | 32 | 1 | |
| 720 | 40 42 | 101 19 | 7.1 | 10 | |
| 721 | 51 23 | 75 5 | 8.7 | 10 | |
| 722 | 53 39 | 101 21 | 8.8 | 10 | |
| 723 | 54 37 | 96 28 | 8.0 | 10 | |
| 724 | 3 59 45 | 103 25 | 8.2 | 10 | |
| 725 | 4 1 53 | 75 5 | 6.1 | 10 | |
| 726 | 1 30 | 105 35 | 8.9 | 10 | |
| 727 | 5 19 | 62 15 | 0.0 | 1 | |
| 728 | 6 50 | 61 17 | 12.4 | 10 | Unequally scattered. |
| 729 | 8 51 | 61 17 | 11.3 | 4 | |
| 730 | 10 14 | 62 13 | 1.— | 1 | |
| 731 | 15 38 | 101 24 | 7.3 | 10 | |
| 732 | 26 53 | 61 19 | 18.2 | 5 | |
| 733 | 28 38 | 101 25 | 7.7 | 10 | |
| 734 | 29 54 | 61 19 | 16.8 | 5 | |
| 735 | 28 29 | 105 38 | 7.8 | 10 | |
| 736 | 34 53 | 61 19 | 5.6 | 5 | |
| 737 | 4 35 44 | 71 19 | 14.3 | 10 | |

REDUCTION OF STAR-GAUGES—Continued.

| No. | R. A. 1860.0. | N. P. D. 1860.0. | No. Stars. | No. Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 738 | 4 37 35 | 101 29 | 8.4 | 10 | |
| 739 | 39 33 | 84 23 | 22.6 | 5 | |
| 740 | 42 18 | 60 56 | 39. | 1 | |
| 741 | 44 31 | 116 38 | 5.5 | 10 | |
| 742 | 49 1 | 71 20 | 22.8 | 5 | All sizes. |
| 743 | 50 34 | 101 30 | 10.7 | 10 | |
| 744 | 53 8 | 108 1 | 13.5 | 10 | |
| 745 | 4 55 40 | 105 44 | 12.3 | 10 | |
| 746 | 5 2 41 | 101 30 | 10.6 | 10 | |
| 747 | 2 42 | 103 31 | 12.3 | 10 | |
| 748 | 10 42 | 101 30 | 13.5 | 10 | |
| 749 | 16 16 | 61 10 | 80. | ½ | |
| 750 | 16 48 | 108 4 | 16.2 | 10 | |
| 751 | 19 57 | 60 51 | 72. | ½ | |
| 752 | 21 39 | 105 46 | 15 8 | 10 | |
| 753 | 26 28 | 116 40 | 11.6 | 10 | |
| 754 | 32 29 | 105 47 | 20.5 | 10 | Many small stars too small for the gauge. |
| 755 | 36 52 | 66 3 | 66. | 1 | |
| 756 | 36 28 | 73 16 | 120. | 1 | |
| 757 | 37 23 | 101 34 | 10.3 | 10 | Unequally scattered. |
| 758 | 40 19 | 100 30 | 4. | 1 | See Journal. |
| 759 | 41 12 | 101 7 | 2. | 1 | |
| 760 | 41 39 | 102 41 | 20. | 1 | |
| 761 | 44 5 | 118 58 | 8.1 | 10 | |
| 762 | 46 27 | 61 21 | 120. | ½ | |
| 763 | 50 27 | 62 3 | 112. | ½ | See Journal, [in pencil.] |
| 764 | 49 28 | 105 49 | 25.8 | 5 | |
| 765 | 5 50 23 | 101 36 | 12.2 | 10 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860.0. | N. P. D. 1860.0. | No. Stars. | No. Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 766 | 5 50 50 | 108 8 | 23.8 | 5 | |
| 767 | 52 46 | 81 41 | 120 | ½ | |
| 768 | 53 58 | 61 53 | 118 | ½ | |
| 769 | 54 57 | 62 16 | 116 | ½ | |
| 770 | 55 16 | 64 28 | 152 | ¼ | Of all sizes. |
| 771 | 5 57 3 | 61 34 | 108 | ½ | |
| 772 | 6 0 16 | 63 29 | 160 | ½ | |
| 773 | 1 1 | 62 42 | 62 | 1 | Faint moonlight. |
| 774 | 5 50 | 108 9 | 31.2 | 5 | |
| 775 | 6 54 | 81 38 | 136 | ½ | |
| 776 | 8 8 | 89 22 | 104 | ¼ | But one of the richest places, etc. |
| 777 | 13 23 | 101 38 | 21.1 | 10 | |
| 778 | 15 28 | 109 27 | 52 | 1 | |
| 779 | 14 35 | 106 55 | 50 | 1 | |
| 780 | 16 14 | 64 46 | 104 | ½ | |
| 781 | 15 36 | 106 18 | 54 | ½ | |
| 782 | 16 24 | 81 48 | 200 | ¼ | |
| 783 | 17 6 | 106 4 | 40 | 1 | |
| 784 | 19 18 | 106 53 | 34 | 1 | |
| 785 | 20 15 | 106 47 | 50 | 1 | |
| 786 | 21 38 | 105 44 | 46 | 1 | |
| 787 | 24 23 | 101 39 | 41.8 | 5 | |
| 788 | 26 7 | 63 49 | 88 | ½ | |
| 789 | 26 42 | 65 38 | 140 | ¼ | |
| 790 | 26 48 | 105 27 | 75 | 1 | |
| 791 | 26 45 | 109 30 | 32 | 1 | |
| 792 | 27 16 | 109 6 | 30 | 1 | |
| 793 | 6 27 46 | 108 44 | 29 | 1 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860.0 | N. P. D. 1860.0 | No. Stars. | No. Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 794 | 6 28 17 | 108 20 | 32. | 1 | |
| 795 | 28 48 | 107 56 | 43. | 1 | |
| 796 | 29 19 | 107 33 | 25. | 1 | |
| 797 | 29 50 | 107 10 | 40. | 1 | |
| 798 | 35 37 | 97 29 | 60. | 1 | |
| 799 | 36 55 | 94 59 | 216. | ½ | |
| 800 | 37 15 | 113 39 | 40. | 1 | |
| 801 | 37 48 | 105 14 | 56. | 1 | |
| 802 | 40 37 | 114 31 | 33. | 1 | |
| 803 | 42 34 | 98 39 | 136. | ½ | |
| 804 | 43 41 | 66 7 | 94. | ½ | |
| 805 | 43 6 | 97 50 | 136. | ½ | |
| 806 | 43 20 | 114 9 | 46. | 1 | |
| 807 | 44 49 | 88 35 | 116. | ½ | See mem. 8′ after the gauge. |
| 808 | 45 34 | 103 11 | 100. | ½ | |
| 809 | 47 0 | 64 25 | 96. | ½ | |
| 810 | 45 45 | 109 31 | 40. | 1 | |
| 811 | 46 16 | 109 7 | 32. | 1 | |
| 812 | 46 37 | 108 45 | 41. | 1 | |
| 813 | 47 35 | 108 22 | 37. | 1 | |
| 814 | 47 33 | 103 34 | 116. | ½ | |
| 815 | 48 35 | 98 19 | 120. | ½ | |
| 816 | 52 17 | 63 3 | 36. | 1 | Large and innumerable, too small, etc. |
| 817 | 50 51 | 113 45 | 42. | 1 | |
| 818 | 54 17 | 63 28 | 92. | ½ | |
| 819 | 53 17 | 113 52 | 59. | 1 | With small stars. |
| 820 | 55 12 | 65 4 | 44. | 1 | Faint twilight, etc. |
| 821 | 6 55 33 | 91 5 | 180. | ½ | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860.0. | N. P. D. 1860.0. | No. Stars. | No. Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 822 | 6 57 17 | 62 59 | 73 | 1 | Many more suspected. |
| 823 | 56 21 | 91 50 | 192 | ½ | |
| 824 | 6 58 11 | 95 8 | 232 | ½ | |
| 825 | 7 0 35 | 107 38 | 100 | ½ | |
| 826 | 1 32 | 104 24 | 136 | ½ | |
| 827 | 52 1 | 107 33 | 128 | ½ | Of all sizes. |
| 828 | 4 35 | 97 37 | 128 | ½ | |
| 829 | 4 52 | 114 19 | 46 | 1 | |
| 830 | 5 37 | 97 12 | 184 | ½ | |
| 831 | 9 10 | 62 23 | 36 | 1 | |
| 832 | 10 31 | 88 55 | 160 | ½ | |
| 833 | 12 17 | 62 59 | 66 | ½ | |
| 834 | 11 18 | 96 56 | 132 | ½ | |
| 835 | 11 58 | 101 39 | 37 | 1 | |
| 836 | 11 50 | 115 35 | 73 | 1 | |
| 837 | 15 0 | 115 38 | 150 | ⅓ | Of all sizes. |
| 838 | 17 40 | 105 13 | 90 | 1 | |
| 839 | 20 6 | 98 13 | 160 | ½ | |
| 840 | 24 47 | 66 15 | 48 | ½ | |
| 841 | 25 18 | 65 48 | 54 | ½ | |
| 842 | 25 57 | 102 19 | 120 | ½ | Changeable focus. |
| 843 | 27 9 | 62 4 | 32 | 1 | |
| 844 | 27 40 | 61 30 | 30 | 1 | |
| 845 | 26 21 | 114 49 | 78 | 1 | |
| 846 | 28 22 | 60 58 | 22 | 1 | |
| 847 | 29 28 | 102 7 | 96 | ½ | |
| 848 | 29 10 | 86 20 | 112 | ½ | |
| 849 | 7 30 37 | 87 42 | 52 | ½ | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860.0. | N.P.D. 1860.0. | No. Stars. | No. Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 850 | 7 30 57 | 102 23 | 100 | ½ | |
| 851 | 32 9 | 86 31 | 48 | ½ | |
| 852 | 32 15 | 98 40 | 104 | ½ | |
| 853 | 33 38 | 106 20 | 184 | ½ | Many such fields. |
| 854 | 34 51 | 115 13 | 184 | ½ | |
| 855 | 35 41 | 105 16 | 212 | ½ | |
| 856 | 36 57 | 102 43 | 46 | 1 | |
| 857 | 38 59 | 101 27 | 52 | 1 | |
| 858 | 40 28 | 102 12 | 58 | 1 | |
| 859 | 42 21 | 115 13 | 212 | ½ | |
| 860 | 43 5 | 98 19 | 92 | ½ | |
| 861 | 44 19 | 61 55 | 39 | 1 | |
| 862 | 43 37 | 108 36 | 176 | ½ | |
| 863 | 47 19 | 60 59 | 23.4 | 5 | |
| 864 | 45 52 | 114 46 | 232 | ½ | |
| 865 | 48 42 | 104 54 | 120 | ½ | But a little hazy. |
| 866 | 50 4 | 59 59 | 25 | 1 | Faint moonlight |
| 867 | 48 57 | 102 56 | 47 | 1 | |
| 868 | 51 27 | 102 51 | 56 | 1 | |
| 869 | 52 38 | 106 50 | 216 | ½ | Mostly small |
| 870 | 54 32 | 97 14 | 45 | 1 | |
| 871 | 59 8 | 63 17 | 17.8 | 10 | |
| 872 | 7 59 58 | 102 15 | 54 | 1 | |
| 873 | 8 0 48 | 116 0 | 200 | ½ | |
| 874 | 6 53 | 114 28 | 108 | ½ | Mostly small |
| 875 | 9 21 | 115 34 | 86 | ½ | |
| 876 | 16 0 | 101 46 | 38 | 1 | |
| 877 | 8 17 52 | 115 30 | 58 | 1 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860.0. | N. P. D. 1860.0. | No. Stars. | No. Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 878 | 8 28 16 | 63 22 | 14.7 | 10 | The stars have been gradually reduced to this number and are still decreasing. |
| 879 | 38 9 | 105 58 | 38 | 1 | |
| 880 | 39 35 | 107 25 | 43 | 1 | |
| 881 | 45 7 | 107 58 | 17 | 1 | |
| 882 | 46 45 | 105 16 | 42 | 1 | |
| 883 | 46 37 | 107 39 | 26 | 1 | |
| 884 | 47 6 | 108 15 | 15 | 1 | |
| 885 | 47 52 | 107 28 | 16 | 1 | |
| 886 | 51 7 | 107 58 | 14.2 | 10 | |
| 887 | 57 43 | 61 1 | 13.8 | 10 | |
| 888 | 59 45 | 40 6 | 12.6 | 10 | |
| 889 | 8 59 7 | 107 58 | 11.6 | 10 | |
| 890 | 9 6 45 | 9 18 | 60–70 | 1 | |
| 891 | 6 52 | 81 35 | 12.3 | 10 | |
| 892 | 17 33 | 104 11 | 19.0 | 5 | |
| 893 | 25 43 | 118 16 | 14.8 | 10 | |
| 894 | 36 11 | 108 18 | 18.0 | 10 | |
| 895 | 37 12 | 95 25 | 14.3 | 10 | |
| 896 | 38 52 | 104 11 | 15.8 | 4 | |
| 897 | 41 10 | 59 1 | 8.7 | 10 | |
| 898 | 43 3 | 61 3 | 9.2 | 10 | |
| 899 | 47 33 | 48 54 | 10.4 | 10 | |
| 900 | 47 50 | 106 10 | 16.0 | 10 | |
| 901 | 52 3 | 58 59 | 8.0 | 10 | |
| 902 | 9 57 20 | 9 24 | 20–30 | 1 | |
| 903 | 10 10 15 | 108 20 | 17.0 | 10 | |
| 904 | 17 48 | 16 26 | 11.2 | 10 | |
| 905 | 15 57 | 59 0 | 6.6 | 10 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860.0. | N. P. D. 1860.0 | No. Stars. | No. Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 906 | 10 21 18 | 118 10 | 9.9 | 10 | |
| 907 | 22 40 | 63 21 | 8.3 | 10 | |
| 908 | 25 12 | 95 32 | 9.6 | 10 | |
| 909 | 36 22 | 59 1 | 5.5 | 10 | |
| 910 | 37 3 | 48 56 | 7.0 | 10 | |
| 911 | 41 31 | 24 1 | 18.2 | 10 | |
| 912 | 46 19 | 105 11 | 8. | 1 | |
| 913 | 52 58 | 16 27 | 10.0 | 10 | |
| 914 | 10 59 47 | 110 46 | 9.9 | 10 | |
| 915 | 11 3 24 | 104 17 | 8.9 | 10 | |
| 916 | 7 46 | 95 34 | 9.6 | 10 | |
| 917 | 16 35 | 110 47 | 10.5 | 10 | |
| 918 | 20 15 | 63 25 | 6.6 | 10 | |
| 919 | 21 45 | 81 36 | 6.3 | 10 | |
| 920 | 28 5 | 16 29 | 11.2 | 10 | |
| 921 | 29 27 | 108 24 | 8.6 | 10 | |
| 922 | 30 3 | 54 47 | 5.6 | 10 | |
| 923 | 40 28 | 108 24 | 5.9 | 10 | |
| 924 | 54 32 | 95 32 | 9.6 | 10 | |
| 925 | 11 57 4 | 63 23 | 4.3 | 10 | |
| 926 | 12 2 2 | 104 17 | 10.3 | 10 | |
| 927 | 9 2 | 63 23 | 5.3 | 10 | |
| 928 | 22 39 | 112 18 | 5.0 | 10 | |
| 929 | 23 10 | 110 37 | 7.9 | 10 | |
| 930 | 25 7 | 119 58 | 9.4 | 10 | |
| 931 | 27 33 | 95 32 | 7.3 | 10 | |
| 932 | 39 53 | 40 12 | 8.0 | 10 | |
| 933 | 40 36 | 108 23 | 9.6 | 10 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860.0. | N. P. D. 1860.0. | No. Stars. | No. Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 934 | 12 52 3 | 110 47 | 8.3 | 10 | Mostly small and many very small suspected. |
| 935 | 12 52 28 | 55 39 | 6.4 | 10 | |
| 936 | 13 8 56 | 69 24 | 6.4 | 10 | |
| 937 | 9 31 | 104 21 | 8.4 | 10 | |
| 938 | 12 55 | 69 24 | 4.6 | 10 | |
| 939 | 12 54 | 63 23 | 5.3 | 10 | |
| 940 | 14 13 | 86 17 | 6.8 | 10 | |
| 941 | 20 15 | 61 10 | 5.6 | 10 | |
| 942 | 21 15 | 61 10 | 6.6 | 10 | |
| 943 | 24 23 | 59 3 | 7.7 | 10 | |
| 944 | 30 8 | 104 17 | 6.9 | 10 | |
| 945 | 32 56 | 67 45 | 5.4 | 10 | |
| 946 | 35 15 | 96 1 | 7.6 | 10 | |
| 947 | 34 2 | 16 29 | 9.3 | 10 | |
| 948 | 49 12 | 110 45 | 10.3 | 10 | |
| 949 | 48 30 | 39 41 | 8.4 | 10 | |
| 950 | 50 21 | 104 15 | 8.9 | 10 | |
| 951 | 50 46 | 63 21 | 5.4 | 10 | |
| 952 | 53 54 | 67 47 | 5.0 | 10 | Most of them small. |
| 953 | 56 15 | 104 15 | 10.2 | 10 | |
| 954 | 13 57 44 | 86 15 | 8.3 | 10 | |
| 955 | 14 4 41 | 108 14 | 10.8 | 10 | |
| 956 | 7 15 | 104 15 | 11.3 | 10 | |
| 957 | 8 58 | 67 43 | 5.8 | 10 | |
| 958 | 8 38 | 16 40 | 11.6 | 5 | |
| 959 | 12 15 | 110 44 | 9.4 | 10 | |
| 960 | 16 15 | 104 12 | 10.3 | 10 | |
| 961 | 15 52 | 57 4 | 10.0 | 10 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860.0. | N.P.D.1860.0. | No. Stars. | No. Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 962 | 14 34 17 | 104 11 | 11.6 | 10 | |
| 963 | 37 29 | 13 40 | 17.2 | 10 | |
| 964 | 47 32 | 53 30 | 9.0 | 10 | |
| 965 | 49 11 | 95 55 | 12.6 | 10 | |
| 966 | 48 42 | 67 32 | 6.5 | 10 | |
| 967 | 50 22 | 104 12 | 12.7 | 10 | |
| 968 | 14 58 51 | 61 4 | 7.0 | 10 | |
| 969 | 15 1 56 | 53 29 | 7.2 | 10 | |
| 970 | 22 14 | 65 6 | 9.9 | 10 | |
| 971 | 26 22 | 89 47 | 11.4 | 10 | |
| 972 | 28 43 | 56 59 | 9.2 | 10 | |
| 973 | 29 19 | 55 28 | 7.0 | 10 | |
| 974 | 30 39 | 91 48 | 7.1 | 10 | Chiefly small. |
| 975 | 32 27 | 87 39 | 15.0 | 10 | Mr. Aubert. |
| 976 | 33 11 | 16 33 | 10.1 | 10 | |
| 977 | 39 27 | 87 39 | 14.2 | 10 | W. H. |
| 978 | 34 26 | 13 30 | 14.8 | 10 | |
| 979 | 41 43 | 56 58 | 12.5 | 10 | |
| 980 | 43 27 | 87 38 | 14.5 | 10 | Mr. Aubert. |
| 981 | 44 24 | 14 26 | 13.9 | 10 | |
| 982 | 51 9 | 53 26 | 9.3 | 10 | |
| 983 | 57 14 | 56 52 | 12.9 | 10 | |
| 984 | 57 14 | 51 3 | 16.7 | 10 | |
| 985 | 59 32 | 91 47 | 11.9 | 10 | Chiefly small. |
| 986 | 59 19 | 16 31 | 15.5 | 10 | |
| 987 | 16 4 34 | 91 46 | 16.2 | 10 | Of various sizes. |
| 988 | 12 28 | 121 47 | 13.6 | 10 | |
| 989 | 18 51 | 87 30 | 17.9 | 9 | |

REDUCTION OF STAR-GAUGES—Continued.

| No. | R. A. 1860.0 | | | N. P. D. 1860.0 | | No. Stars. | No. Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | ° | ′ | | | |
| 990 | | 26 | 26 | 87 | 33 | 11.8 | 10 | Mr. Aubert. |
| 991 | | 45 | 14 | 119 | 9 | 27.6 | 10 | |
| 992 | | 45 | 10 | 84 | 7 | 19.1 | 10 | |
| 993 | | 47 | 24 | 23 | 6 | 15.8 | 10 | |
| 994 | 17 | 3 | 0 | 24 | 1 | 18.6 | 5 | |
| 995 | | 29 | 28 | 55 | 38 | 41.2 | 5 | |
| 996 | | 31 | 55 | 109 | 50 | 0. | 1 | |
| 997 | | 32 | 17 | 110 | 43 | 34. | 1 | |
| 998 | 17 | 40 | 38 | 103 | 13 | 60. | 1 | But is one of the richest fields etc. |
| 999 | 18 | 58 | 39 | 87 | 23 | 90. | 1 | |
| 1000 | 19 | 7 | 3 | 118 | 14 | 26.2 | 5 | |
| 1001 | | 19 | 0 | 86 | 51 | 220. | ¼ | Sw. not entered? 6, 7, 8, 9. |
| 1002 | | 22 | 4 | 86 | 56 | 150. | 1 | |
| 1003 | | 29 | 14 | 86 | 18 | 172. | ¼ | Sw. not entered? 6, 7, 8, 9. |
| 1004 | | 37 | 5 | 72 | 2 | 360. | ¼ | See mem., 36598 stars have been seen in 6. |
| 1005 | | 38 | 27 | 74 | 56 | 600. | ¼ | |
| 1006 | | 42 | 15 | 87 | 12 | 144. | ¼ | Sw. not entered; 6, 7, 8, 9. |
| 1007 | | 44 | 17 | 52 | 16 | 480. | ¼ | |
| 1008 | | 47 | 18 | 30 | 14 | 112. | ½ | The whole breadth equally rich, see mem. with many too small to be counted. |
| 1009 | | 48 | 19 | 52 | 19 | 612. | ¼ | |
| 1010 | | 52 | 12 | 46 | 52 | 240. | ¼ | |
| 1011 | | 55 | 15 | 47 | 53 | 264. | ¼ | |
| 1012 | | 56 | 24 | 74 | 0 | 440. | ¼ | |
| 1013 | | 58 | 14 | 79 | 41 | 252. | ¼ | |
| 1014 | 19 | 59 | 59 | 118 | 12 | 10.5 | 10 | |
| 1015 | 20 | 3 | 36 | 84 | 19 | 92. | ½ | |
| 1016 | | 8 | 22 | 72 | 42 | 360. | ¼ | |
| 1017 | | 9 | 36 | 67 | 16 | 93. | 1 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860. 0. | N. P. D. 1860.0 | No. Stars. | No. Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 1018 | 15 49 | 87 51 | 46 | 1 | |
| 1019 | 17 18 | 86 51 | 41.4 | 5 | |
| 1020 | 19 24 | 72 53 | 260 | ½ | See rest of memoranda. |
| 1021 | 20 8 | 84 48 | 45 | 1 | |
| 1022 | 20 21 | 98 4 | 80 | ½ | Very clear and with great attention. |
| 1023 | 24 0 | 120 15 | 7.2 | 10 | |
| 1024 | 24 38 | 85 25 | 67 | 1 | |
| 1025 | 25 8 | 85 14 | 50 | 1 | |
| 1026 | 26 19 | 84 50 | 48 | 1 | |
| 1027 | 27 20 | 84 26 | 52 | 1 | |
| 1028 | 28 27 | 84 1 | 40 | 1 | |
| 1029 | 29 24 | 83 39 | 43 | 1 | |
| 1030 | 31 35 | 118 7 | 10.9 | 10 | |
| 1031 | 33 17 | 44 41 | 172 | ½ | |
| 1032 | 33 15 | 43 38 | 232 | ½ | |
| 1033 | 41 50 | 20 21 | 48 | 1 | Besides many too small to be distinctly seen. |
| 1034 | 43 35 | 54 17 | 320 | ½ | |
| 1035 | 46 8 | 94 10 | 18.4 | 5 | |
| 1036 | 46 49 | 118 5 | 6.9 | 10 | |
| 1037 | 55 56 | 66 29 | 184 | ½ | |
| 1038 | 55 11 | 39 33 | 15 | 1 | Note illegible in *my* copy. |
| 1039 | 55 31 | 38 38 | 41 | 1 | |
| 1040 | 57 55 | 120 12 | 4.3 | 10 | |
| 1041 | 57 12 | 40 4 | 17 | 1 | |
| 1042 | 20 58 32 | 51 59 | 220 | ½ | |
| 1043 | 21 2 0 | 43 32 | 360–400 | ½ | |
| 1044 | 5 20 | 86 23 | 18.2 | 10 | [Sw. not entered. ? 6, 7, 8, 9. |
| 1045 | 6 46 | 118 2 | 6.5 | 10 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860.0. | N. P. D. 1860.0. | No. Stars. | No. Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 1046 | 21 6 3 | 43 24 | 280. | ¼ | |
| 1047 | 15 48 | 79 36 | 28. | 1 | |
| 1048 | 16 40 | 52 14 | 272. | ¼ | Mostly very small. |
| 1049 | 17 7 | 81 53 | 40. | 1 | |
| 1050* | 21 38 | 21 31 | 32. | 1 | *Probably affected by haziness. |
| 1051 | 31 20 | 40 45 | 360. | ¼ | But most of them so small, etc. |
| 1052 | 34 48 | 120 9 | 4.5 | 10 | |
| 1053 | 51 55 | 37 44 | 280.. | ¼ | See mem. on appearance of heavens. |
| 1054 | 53 2 | 116 39 | 6.2 | 10 | |
| 1055 | 53 26 | 37 49 | 336. | ¼ | |
| 1056 | 57 4 | 114 39 | 5.8 | 10 | |
| 1057 | 21 58 34 | 66 13 | 46. | 1 | |
| 1058 | 22 8 2 | 114 38 | 5.8 | 10 | |
| 1059 | 14 16 | 11 40 | 20.3 | 10 | Mostly extra small. |
| 1060 | 16 17 | 86 20 | 10.7 | 10 | [Sw. not entered ?, 6, 7, 8, 9.] |
| 1061 | 23 51 | 90 20 | 9.2 | 1 | [Sic in m. s.] |
| 1062 | 32 21 | 90 19 | 9.2 | 1 | [Sic in m. s.] |
| 1063 | 35 3 | 91 57 | 7.8 | 10 | |
| 1064 | 38 43 | 120 18 | 2.9 | 10 | |
| 1065 | 39 56 | 114 39 | 4.9 | 10 | |
| 1070 | 43 48 | 116 39 | 3.3 | 10 | |
| 1071 | 49 4 | 91 57 | 7.2 | 10 | |
| 1072 | 22 58 6 | 88 21 | 7.1 | 10 | |
| 1073 | 23 0 14 | 100 57 | 6.3 | 10 | |
| 1074 | 0 52 | 114 38 | 2.8 | 10 | |
| 1075 | 6 22 | 102 53 | 6.1 | 10 | |
| 1076 | 13 50 | 114 38 | 3.5 | 10 | |
| 1077 | 17 24 | 102 53 | 5.3 | 10 | |

REDUCTION OF STAR-GAUGES — Continued.

| No. | R. A. 1860.0. | N. P. D. 1860.0. | No. Stars. | No. Fields. | HERSCHEL'S Remarks. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 1078 | 23 20 26 | 120 5 | 2.3 | 10 | |
| 1079 | 21 21 | 86 16 | 5.0 | 10 | Sw. not entered, ? 2, 6, 7, 8, 9. |
| 1080 | 26 0 | 109 53 | 5.6 | 10 | |
| 1081 | 28 31 | 92 5 | 6.3 | 10 | |
| 1082 | 36 36 | 116 38 | 4.8 | 10 | |
| 1083 | 37 50 | 90 14 | 7.2 | 10 | |
| 1084 | 38 29 | 95 56 | 3.4 | 10 | |
| 1085 | 41 21 | 120 5 | 2.4 | 10 | The small speculum affected by damp. |
| 1086 | 51 4 | 95 56 | 6.0 | 10 | |
| 1087 | 52 56 | 109 53 | 3.9 | 10 | |
| 1088 | 23 53 41 | 114 37 | 4.0 | 10 | |

## XII. COUNTS OF STARS FROM THE CELESTIAL CHARTS OF DR. C. H. F. PETERS, PROF. J. C. WATSON, THE PARIS CHARTS OF CHACORNAC (COMPLETED BY DR. PETERS) AND THE ECLIPTIC-CHARTS OF HERR J. PALISA.

In May 1878 I had the pleasure of visiting Dr. C. H. F. PETERS at his observatory and of inspecting his series of celestial charts, then unpublished. He was kind enough to allow me to make a count of the number of stars contained in each 4m of R. A. by 1° in Dec. on every one of his maps then completed. I counted the stars on very many of the Paris charts which Dr. PETERS had also completed by inserting the missing stars. Such Paris charts as I counted were in every way comparable with those which Dr. PETERS had himself made, and for the present purpose they may be considered a part of the same series. At the date of my counting, the maps were regarded as practically completed down to a certain magnitude. I myself made a careful comparison of a map (No. I of the published charts) with the sky, and no stars were omitted except the very faintest—those which could only be seen with careful attention in a perfectly dark field with the eye protected from all extraneous light. The *minimum visibile* of Dr. PETERS' telescope (aperture 13.5 inches) is 14.8 or 14.9 mag. on ARGELANDER'S DM. scale extended. The stars omitted could not have been above 13.5 mag.

The maps counted were selected for me by Dr. PETERS, and were all equally complete up to this point. So that the numbers which are given in the table first following, so far as they are derived from Dr. PETERS' *ms.* maps, and from CHACORNAC'S charts, completed by DR. PETERS, are to be considered as homogeneous *gauges* or counts of all stars existing in the squares counted, from the brightest stars down to a certain (unknown) magnitude. This unknown magnitude cannot be far from the 14th. Exactly what it is, can be determined in the following way. Some of the squares of Dr. PETERS' charts, and of CHACORNAC'S charts, as completed by Dr. PETERS fall on the areas within which the Harvard

college observatory intends to determine the magnitude of each star separately, in order to establish standards of stellar magnitude. Fortunately for this purpose I have a photo-lithographic proof of PETERS' (published) Chart No. I, which was made in 1878, and which therefore accurately represents the state of his *ms.* maps at this time, before they had been repeatedly revised. This has been carefully compared with the map as published. All of the stars added since 1878 may be considered as being of the 13th magnitude, or fainter. In comparing these maps I have seen that the lines of R. A. and Dec. have been redrawn by the photo-lithographer, and that in a few cases stars have been covered up by the process. This should be noted by the owners of the charts. The CHACORNAC charts are now in exactly the same state as when I counted them, as are also some of the *ms.* (unpublished) charts of Dr. PETERS. A comparison of these with the Harvard college results will show the limiting magnitude of the counts which immediately follow (Table I). I cannot too strongly insist on the fact that these numbers represent the numbers of stars which actually exist in the sky down to a certain magnitude (as yet not determined) as accurately, or even more accurately, than a series of gauges would do, if the gauges were made with a telescope smaller than Dr. PETERS' Clinton refractor, say of twelve inches aperture.

Since my counts were made, Dr. PETERS has published, at his own expense, twenty of these celestial charts which are now in the hands of Astronomers, by his kindness. These twenty are no longer in the state in which they were when I counted (certain parts) of them. *Every* star visible in the Clinton refractor down to the very limit of visibility has been inserted by repeated revisions and re-revisions, so that we really have a new and most accurate series of gauges in which the smallest star included is about of the 14.8 magnitude.

The exact limit of magnitude of the published charts can be determined in the same way as before. The force of the statement that we have here *two series* of gauges, one from Dr. PETERS' *ms.* maps and one from his published maps can

only be appreciated after a careful study of the sky with his published maps and the identification of all the stars laid down by Dr. PETERS in a certain region. It can only be appreciated fully, by going through my own experience: that is after having compared a whole map (5 degrees square) and identifying every star; by comparing this map with others in *ms.*, and then with the published map, and finally by comparing the published map with the sky. I might properly add that an acquaintance with Dr. PETERS' most methodical and elegant methods of work is also necessary. I therefore believe that the following tables furnish us with two series of star gauges of great accuracy.

The series from the *ms.* maps, Table I, gives every star from the brightest down to a faint magnitude as yet undetermined (say A). The series from the published maps, Table II. gives every star down to the faintest visible (say B). A comparison of the two will give all the stars of the magnitudes between A and B. I believe the counts in these two tables are of equal importance with a series of independent gauges, made especially for the purpose of determining the number of stars in each field, and in some respects they are even superior to such gauges.

Table I contains all these counts from DR. PETERS' ms. maps, and from CHACORNAC'S charts (completed.) The table gives *first*, the current number, *second*, the R. A., and *third*, the Declination of the middle of the space counted (4 m. in R. A. by 60′ in Dec.) for 1860, *fourth*, the number of stars actually mapped, *fifth*, this number multiplied by sec. $\delta$ and *sixth* the designation of the authority, where P. MS. stands for DR. PETERS' Ms. and C stands for CHACORNAC'S published charts completed by DR. PETERS.

The counts credited to PROFESSOR WATSON'S maps, Table I. were made by me from his *ms.* maps which are the property of the National Academy of Sciences and are now loaned to the Washburn Observatory. These maps are not in a state for publication, and only a few portions of them are manifestly complete. Such portions I have counted. In all cases the counts serve for 1860.0. Where the epoch of the maps was different allowance has been made for precession.

Nebulæ were omitted from the counts. Close double stars were counted as one star. Wide doubles (30″ and upwards) were counted as two stars.

The counts for Table II. were made by Mr. GEORGE W. BROWN, student in the University, under my direction. They can be verified by consulting Dr. PETERS' published charts. It must be remembered, however, that these charts were printed by photo-lithography, and that there may be a slight difference between each two sets of maps, in the very faintest stars (only). It must also be remembered that the very slight differences named are no more, or even less, than the discrepancies which arise in different counts of the same field in actual gauging.

In a very few cases the numbers of stars counted by me are slightly more than those in the published charts, but in no case is the error material.

Dr. J. PALISA has been so kind as to prepare for me a series of gauges from his own *ms.* maps, which are given in Table III., following this. They include all stars from the brightest down to certain (undetermined) faintest, which could be seen in his two telescopes, viz.: Telescope I, the 6-inch refractor of the observatory of Pola, and Telescope II, the 12-inch refractor of the observatory of Vienna. The table gives, *first,* a current number for reference; *second,* the R. A. and Dec. for 1860 of the center of the space counted; *third,* the telescope with which the map was made; *fourth,* the number of stars laid down in the map within an area of 2m in R. A. by 30′ in Dec. The *fifth* column contains the quantity 4 sec. $\delta$ (No. of stars), and expresses the number of stars which would have been mapped in one square degree, provided the distribution of stars over this degree is the same as it is over the 2m in R. A. by 30′ in Decination, which was actually counted.

TABLE I.—COUNTS OF STARS FROM THE MS. CHARTS OF DR. C. H. F. PETERS, PROFESSOR J. C. WATSON, AND FROM CHACORNAC'S CHARTS COMPLETED BY DR. PETERS.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 1 | 0 2 | + 7 30 | 53 | 54 | WATSON. |
| 2 | 0 2 | + 6 30 | 47 | 47 | WATSON. |
| 3 | 0 2 | + 0 30 | 44 | 44 | C. |
| 4 | 0 2 | — 0 30 | 53 | 53 | C. |
| 5 | 0 2 | — 1 30 | 41 | 41 | C. |
| 6 | 0 2 | — 2 30 | 37 | 37 | C. |
| 7 | 0 2 | — 3 30 | 64 | 64 | C. |
| 8 | 0 6 | + 7 30 | 45 | 45 | WATSON. |
| 9 | 0 6 | + 6 30 | 49 | 49 | WATSON. |
| 10 | 0 6 | + 5 30 | 42 | 42 | C. |
| 11 | 0 6 | + 4 30 | 51 | 51 | C. |
| 12 | 0 6 | + 3 30 | 47 | 47 | C. |
| 13 | 0 6 | + 2 30 | 52 | 52 | C. |
| 14 | 0 6 | + 1 30 | 56 | 56 | C. |
| 15 | 0 6 | + 0 30 | 49 | 49 | C. |
| 16 | 0 6 | — 0 30 | 48 | 48 | C. |
| 17 | 0 6 | — 1 30 | 54 | 54 | C. |
| 18 | 0 6 | — 2 30 | 58 | 58 | C. |
| 19 | 0 6 | — 3 30 | 42 | 42 | C. |
| 20 | 0 10 | + 7 30 | 43 | 43 | WATSON. |
| 21 | 0 10 | + 6 30 | 40 | 40 | WATSON. |
| 22 | 0 10 | + 5 30 | 58 | 58 | C. |
| 23 | 0 10 | + 4 30 | 42 | 42 | C. |
| 24 | 0 10 | + 3 30 | 47 | 47 | C. |

TABLE I—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars. Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 25 | 0 10 | + 2 30 | 46 | 46 | C. |
| 26 | 0 10 | + 1 30 | 51 | 51 | C. |
| 27 | 0 10 | + 0 30 | 57 | 57 | C. |
| 28 | 0 10 | — 0 30 | 53 | 53 | C. |
| 29 | 0 10 | — 1 30 | 52 | 52 | C. |
| 30 | 0 10 | — 2 30 | 70 | 70 | C. |
| 31 | 0 10 | — 3 30 | 40 | 40 | C. |
| 32 | 0 14 | + 5 30 | 69 | 69 | C. |
| 33 | 0 14 | + 4 30 | 56 | 56 | C. |
| 34 | 0 14 | + 3 30 | 87 | 87 | C. |
| 35 | 0 14 | + 2 30 | 48 | 48 | C. |
| 36 | 0 14 | + 1 30 | 53 | 53 | C. |
| 37 | 0 14 | + 0 30 | 61 | 61 | C. |
| 38 | 0 14 | — 0 30 | 56 | 56 | C. |
| 39 | 0 14 | — 1 30 | 37 | 37 | C. |
| 40 | 0 14 | — 2 30 | 50 | 50 | C. |
| 41 | 0 14 | — 3 30 | 54 | 54 | C. |
| 42 | 0 18 | + 5 30 | 57 | 57 | C. |
| 43 | 0 18 | + 4 30 | 80 | 80 | C. |
| 44 | 0 18 | + 3 30 | 77 | 77 | C. |
| 45 | 0 18 | + 2 30 | 68 | 68 | C. |
| 46 | 0 18 | + 1 30 | 50 | 50 | C. |
| 47 | 0 18 | + 0 30 | 52 | 52 | C. |
| 48 | 0 18 | — 0 30 | 49 | 49 | C. |
| 49 | 0 18 | — 1 30 | 34 | 34 | C. |
| 50 | 0 18 | — 2 30 | 64 | 64 | C. |
| 51 | 0 18 | — 3 30 | 63 | 63 | C. |
| 52 | 0 42 | + 9 30 | 77 | 78 | C. |

TABLE I — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 53 | 0 42 | +8 30 | 85 | 86 | C. |
| 54 | 0 42 | +7 30 | 64 | 64 | C. |
| 55 | 0 42 | +6 30 | 69 | 69 | C. |
| 56 | 0 42 | +4 30 | 42 | 42 | C. |
| 57 | 0 42 | +3 30 | 50 | 50 | C. |
| 58 | 0 42 | +2 30 | 44 | 44 | C. |
| 59 | 0 42 | +1 30 | 40 | 40 | C. |
| 60 | 0 46 | +9 30 | 67 | 68 | C. |
| 61 | 0 46 | +8 30 | 58 | 59 | C. |
| 62 | 0 46 | +7 30 | 71 | 72 | C. |
| 63 | 0 46 | +6 30 | 74 | 74 | C. |
| 64 | 0 46 | +4 30 | 59 | 59 | C. |
| 65 | 0 46 | +3 30 | 49 | 49 | C. |
| 66 | 0 46 | +2 30 | 46 | 46 | C. |
| 67 | 0 46 | +1 30 | 55 | 55 | C. |
| 68 | 0 50 | +9 30 | 79 | 80 | C. |
| 69 | 0 50 | +8 30 | 63 | 64 | C. |
| 70 | 0 50 | +7 30 | 66 | 67 | C. |
| 71 | 0 50 | +6 30 | 64 | 64 | C. |
| 72 | 0 50 | +4 30 | 70 | 70 | C. |
| 73 | 0 50 | +3 30 | 61 | 61 | C. |
| 74 | 0 50 | +2 30 | 51 | 51 | C. |
| 75 | 0 50 | +1 30 | 56 | 56 | C. |
| 76 | 0 54 | +9 30 | 77 | 78 | C. |
| 77 | 0 54 | +8 30 | 78 | 79 | C. |
| 78 | 0 54 | +7 30 | 63 | 64 | C. |
| 79 | 0 54 | +6 30 | 72 | 72 | C. |
| 80 | 0 54 | +4 30 | 66 | 66 | C. |

TABLE I.— COUNTS OF STARS — Continued.

| No. | R. A. 1860.0 | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 81 | 0 54 | + 3 30 | 60 | 60 | C. |
| 82 | 0 54 | + 2 30 | 50 | 50 | C. |
| 83 | 0 54 | + 1 30 | 69 | 69 | C. |
| 84 | 0 58 | + 9 30 | 70 | 71 | C. |
| 85 | 0 58 | + 8 30 | 62 | 63 | C. |
| 86 | 0 58 | + 7 30 | 62 | 63 | C. |
| 87 | 0 58 | + 6 30 | 63 | 63 | C. |
| 88 | 0 58 | + 4 30 | 56 | 56 | C. |
| 89 | 0 58 | + 3 30 | 52 | 52 | C. |
| 90 | 0 58 | + 2 30 | 55 | 55 | C. |
| 91 | 0 58 | + 1 30 | 54 | 54 | C. |
| 92 | 1 2 | +14 30 | 80 | 82 | P. Ms. |
| 93 | 1 2 | +13 30 | 76 | 78 | P. Ms. |
| 94 | 1 2 | +12 30 | 71 | 73 | P. Ms. |
| 95 | 1 2 | +11 30 | 73 | 74 | P. Ms. |
| 96 | 1 2 | +10 30 | 67 | 68 | P. Ms. |
| 97 | 1 2 | + 4 30 | 74 | 74 | P. Ms. |
| 98 | 1 2 | + 3 30 | 56 | 56 | P. Ms. |
| 99 | 1 2 | + 2 30 | 68 | 68 | P. Ms. |
| 100 | 1 2 | + 1 30 | 64 | 64 | P. Ms. |
| 101 | 1 2 | + 0 30 | 74 | 74 | P. Ms. |
| 102 | 1 6 | +14 30 | 84 | 86 | P. Ms. |
| 103 | 1 6 | +13 30 | 87 | 89 | P. Ms. |
| 104 | 1 6 | +12 30 | 72 | 73 | P. Ms. |
| 105 | 1 6 | +11 30 | 63 | 64 | P. Ms. |
| 106 | 1 6 | +10 30 | 69 | 70 | P. Ms. |
| 107 | 1 6 | + 4 30 | 90 | 90 | P. Ms. |
| 108 | 1 6 | + 3 30 | 76 | 76 | P. Ms. |

TABLE I — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 109 | 1 6 | + 2 30 | 70 | 70 | P. Ms. |
| 110 | 1 6 | + 1 30 | 66 | 66 | P. Ms. |
| 111 | 1 6 | + 0 30 | 68 | 68 | P. Ms. |
| 112 | 1 10 | +14 30 | 79 | 81 | P. Ms. |
| 113 | 1 10 | +13 30 | 81 | 82 | P. Ms. |
| 114 | 1 10 | +12 30 | 83 | 85 | P. Ms. |
| 115 | 1 10 | +11 30 | 70 | 71 | P. Ms. |
| 116 | 1 10 | +10 30 | 76 | 77 | P. Ms. |
| 117 | 1 10 | + 4 30 | 67 | 67 | P. Ms. |
| 118 | 1 10 | + 3 30 | 62 | 62 | P. Ms. |
| 119 | 1 10 | + 2 30 | 67 | 67 | P. Ms. |
| 120 | 1 10 | + 1 30 | 70 | 70 | P. Ms. |
| 121 | 1 10 | + 0 30 | 68 | 68 | P. Ms. |
| 122 | 1 14 | +14 30 | 71 | 73 | P. Ms. |
| 123 | 1 14 | +13 30 | 82 | 84 | P. Ms. |
| 124 | 1 14 | +12 30 | 75 | 76 | P. Ms. |
| 125 | 1 14 | +11 30 | 71 | 72 | P. Ms. |
| 126 | 1 14 | +10 30 | 66 | 67 | P. Ms. |
| 127 | 1 14 | + 4 30 | 68 | 68 | P. Ms. |
| 128 | 1 14 | + 3 30 | 69 | 69 | P. Ms. |
| 129 | 1 14 | + 2 30 | 46 | 46 | P. Ms. |
| 130 | 1 14 | + 1 30 | 69 | 69 | P. Ms. |
| 131 | 1 14 | + 0 30 | 54 | 54 | P. Ms. |
| 132 | 1 18 | +14 30 | 64 | 66 | P. Ms. |
| 133 | 1 18 | +13 30 | 68 | 70 | P. Ms. |
| 134 | 1 18 | +12 30 | 57 | 58 | P. Ms. |
| 135 | 1 18 | +11 30 | 68 | 69 | P. Ms. |
| 136 | 1 18 | +10 30 | 83 | 84 | P. Ms. |

TABLE I—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 137 | 1 18 | + 4 30 | 75 | 75 | P. Ms. |
| 138 | 1 18 | + 3 30 | 55 | 55 | P. Ms. |
| 139 | 1 18 | + 2 30 | 55 | 55 | P. Ms. |
| 140 | 1 18 | + 1 30 | 67 | 67 | P. Ms. |
| 141 | 1 18 | + 0 30 | 82 | 82 | P. Ms. |
| 142 | 1 22 | +14 30 | 73 | 75 | P. Ms. |
| 143 | 1 22 | +13 30 | 50 | 51 | P. Ms. |
| 144 | 1 22 | +12 30 | 44 | 45 | P. Ms. |
| 145 | 1 26 | +14 30 | 58 | 60 | P. Ms. |
| 146 | 1 26 | +13 30 | 64 | 66 | P. Ms. |
| 147 | 1 26 | +12 30 | 56 | 57 | P. Ms. |
| 148 | 1 30 | +14 30 | 42 | 43 | P. Ms. |
| 149 | 1 30 | +13 30 | 81 | 83 | P. Ms. |
| 150 | 1 30 | +12 30 | 58 | 59 | P. Ms. |
| 151 | 1 34 | +14 30 | 59 | 61 | P. Ms. |
| 152 | 1 34 | +13 30 | 64 | 66 | P. Ms. |
| 153 | 1 34 | +12 30 | 68 | 69 | P. Ms. |
| 154 | 1 38 | +14 30 | 53 | 55 | P. Ms. |
| 155 | 1 38 | +13 30 | 39 | 40 | P. Ms. |
| 156 | 1 38 | +12 30 | 74 | 75 | P. Ms. |
| 157 | 1 46 | +12 30 | 69 | 70 | C. |
| 158 | 1 46 | +11 30 | 61 | 62 | C. |
| 159 | 1 46 | +10 30 | 65 | 66 | C. |
| 160 | 1 50 | +12 30 | 67 | 68 | C. |
| 161 | 1 50 | +11 30 | 91 | 93 | C. |
| 162 | 1 50 | +10 30 | 58 | 59 | C. |
| 163 | 1 54 | +12 30 | 71 | 72 | C. |
| 164 | 1 54 | +11 30 | 68 | 69 | C. |

TABLE I — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 165 | 1 54 | +10 30 | 63 | 64 | C. |
| 166 | 1 58 | +12 30 | 90 | 92 | C. |
| 167 | 1 58 | +11 30 | 78 | 79 | C. |
| 168 | 1 58 | +10 30 | 75 | 76 | C. |
| 169 | 3 2 | +19 30 | 76 | 80 | P. Ms. |
| 170 | 3 2 | +18 30 | 117 | 123 | P. Ms. |
| 171 | 3 2 | +17 30 | 89 | 93 | P. Ms. |
| 172 | 3 2 | +16 30 | 96 | 100 | P. Ms. |
| 173 | 3 2 | +15 30 | 84 | 86 | P. Ms. |
| 174 | 3 6 | +19 30 | 70 | 74 | P. Ms. |
| 175 | 3 6 | +18 30 | 90 | 95 | P. Ms. |
| 176 | 3 6 | +17 30 | 105 | 110 | P. Ms. |
| 177 | 3 6 | +16 30 | 73 | 76 | P. Ms. |
| 178 | 3 6 | +15 30 | 90 | 94 | P. Ms. |
| 179 | 3 10 | +19 30 | 92 | 97 | P. Ms. |
| 180 | 3 10 | +18 30 | 87 | 92 | P. Ms. |
| 181 | 3 10 | +17 30 | 75 | 79 | P. Ms. |
| 182 | 3 10 | +16 30 | 84 | 87 | P. Ms. |
| 183 | 3 10 | +15 30 | 86 | 88 | P. Ms. |
| 184 | 3 14 | +19 30 | 58 | 60 | P. Ms. |
| 185 | 3 14 | +18 30 | 82 | 86 | P. Ms. |
| 186 | 3 14 | +17 30 | 64 | 67 | P. Ms. |
| 187 | 3 14 | +16 30 | 96 | 100 | P. Ms. |
| 188 | 3 14 | +15 30 | 91 | 95 | P. Ms. |
| 189 | 3 18 | +19 30 | 62 | 66 | P. Ms. |
| 190 | 3 18 | +18 30 | 71 | 75 | P. Ms. |
| 191 | 3 18 | +17 30 | 61 | 64 | P. Ms. |
| 192 | 3 18 | +16 30 | 86 | 89 | P. Ms. |

TABLE I.—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 193 | 3 18 | +15 30 | 91 | 95 | P. Ms. |
| 194 | 4 2 | +23 30 | 84 | 91 | C. |
| 195 | 4 2 | +22 30 | 84 | 90 | C. |
| 196 | 4 2 | +21 30 | 75 | 80 | C. |
| 197 | 4 2 | +20 30 | 45 | 47 | C. |
| 198 | 4 2 | +19 30 | 54 | 57 | C. |
| 199 | 4 6 | +23 30 | 80 | 87 | C. |
| 200 | 4 6 | +22 30 | 61 | 66 | C. |
| 201 | 4 6 | +21 30 | 53 | 57 | C. |
| 202 | 4 6 | +20 30 | 46 | 49 | C. |
| 203 | 4 6 | +19 30 | 50 | 53 | C. |
| 204 | 4 10 | +23 30 | 86 | 94 | C. |
| 205 | 4 10 | +22 30 | 101 | 109 | C. |
| 206 | 4 10 | +21 30 | 56 | 60 | C. |
| 207 | 4 10 | +20 30 | 53 | 56 | C. |
| 208 | 4 10 | +19 30 | 54 | 57 | C. |
| 209 | 4 14 | +23 30 | 75 | 81 | C. |
| 210 | 4 14 | +22 30 | 94 | 101 | C. |
| 211 | 4 14 | +21 30 | 66 | 71 | C. |
| 212 | 4 14 | +20 30 | 80 | 85 | C. |
| 213 | 4 14 | +19 30 | 57 | 60 | C. |
| 214 | 4 18 | +23 30 | 72 | 78 | C. |
| 215 | 4 18 | +22 30 | 69 | 74 | C. |
| 216 | 4 18 | +21 30 | 64 | 68 | C. |
| 217 | 4 18 | +20 30 | 39 | 42 | C. |
| 218 | 4 18 | +19 30 | 46 | 49 | C. |
| 219 | 4 42 | +24 30 | 44 | 48 | C. |
| 220 | 4 42 | +23 30 | 57 | 62 | C. |

TABLE I—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 221 | 4 42 | +22 30 | 69 | 74 | C. |
| 222 | 4 42 | +21 30 | 124 | 134 | C. |
| 223 | 4 42 | +20 30 | 121 | 129 | C. |
| 224 | 4 46 | +24 30 | 69 | 76 | C. |
| 225 | 4 46 | +23 30 | 90 | 98 | C. |
| 226 | 4 46 | +22 30 | 93 | 100 | C. |
| 227 | 4 46 | +21 30 | 129 | 139 | C. |
| 228 | 4 46 | +20 30 | 151 | 160 | C. |
| 229 | 4 50 | +24 30 | 85 | 93 | C. |
| 230 | 4 50 | +23 30 | 78 | 85 | C. |
| 231 | 4 50 | +22 30 | 110 | 119 | C. |
| 232 | 4 50 | +21 30 | 140 | 149 | C. |
| 233 | 4 50 | +20 30 | 137 | 146 | C. |
| 234 | 4 54 | +24 30 | 106 | 117 | C. |
| 235 | 4 54 | +23 30 | 178 | 193 | C. |
| 236 | 4 54 | +22 30 | 104 | 112 | C. |
| 237 | 4 54 | +21 30 | 155 | 166 | C. |
| 238 | 4 54 | +20 30 | 149 | 158 | C. |
| 239 | 4 58 | +24 30 | 117 | 129 | C. |
| 240 | 4 58 | +23 30 | 133 | 145 | C. |
| 241 | 4 58 | +22 30 | 128 | 138 | C. |
| 242 | 4 58 | +21 30 | 149 | 159 | C. |
| 243 | 4 58 | +20 30 | 138 | 147 | C. |
| 244 | 7 54 | +15 30 | 168 | 174 | P. Ms. |
| 245 | 7 58 | +15 30 | 84 | 87 | P. Ms. |
| 246 | 8 26 | +20 30 | 59 | 63 | C. |
| 247 | 8 26 | +19 30 | 71 | 75 | C. |
| 248 | 8 26 | +18 30 | 84 | 88 | C. |

TABLE I — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 249 | 8 26 | +17 30 | 65 | 68 | C. |
| 250 | 8 30 | +20 30 | 82 | 88 | C. |
| 251 | 8 30 | +19 30 | 87 | 92 | C. |
| 252 | 8 30 | +18 30 | 78 | 82 | C. |
| 253 | 8 30 | +17 30 | 70 | 74 | C. |
| 254 | 8 34 | +20 30 | 110 | 118 | C. |
| 255 | 8 34 | +19 30 | 99 | 105 | C. |
| 256 | 8 34 | +18 30 | 57 | 60 | C. |
| 257 | 8 34 | +17 30 | 70 | 74 | C. |
| 258 | 8 38 | +20 30 | 79 | 85 | C. |
| 259 | 8 38 | +19 30 | 75 | 79 | C. |
| 260 | 8 38 | +18 30 | 65 | 68 | C. |
| 261 | 8 38 | +17 30 | 71 | 74 | C. |
| 262 | 8 46 | +19 30 | 54 | 57 | C. |
| 263 | 8 46 | +18 30 | 64 | 67 | C. |
| 264 | 8 46 | +17 30 | 48 | 50 | C. |
| 265 | 8 46 | +16 30 | 85 | 88 | C. |
| 266 | 8 50 | +19 30 | 71 | 75 | C. |
| 267 | 8 50 | +18 30 | 65 | 68 | C. |
| 268 | 8 50 | +17 30 | 53 | 56 | C. |
| 269 | 8 50 | +16 30 | 70 | 73 | C. |
| 270 | 8 54 | +19 30 | 66 | 70 | C. |
| 271 | 8 54 | +18 30 | 54 | 57 | C. |
| 272 | 8 54 | +17 30 | 61 | 64 | C. |
| 273 | 8 54 | +16 30 | 80 | 84 | C. |
| 274 | 8 58 | +19 30 | 60 | 63 | C. |
| 275 | 8 58 | +18 30 | 64 | 67 | C. |
| 276 | 8 58 | +17 30 | 67 | 70 | C. |

TABLE I.—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | | | | |
| 277 | 8 58 | +16 30 | 69 | 71 | C. |
| 278 | 9 6 | +18 30 | 52 | 55 | C. |
| 279 | 9 6 | +17 30 | 66 | 69 | C. |
| 280 | 9 6 | +16 30 | 65 | 68 | C. |
| 281 | 9 6 | +15 30 | 60 | 62 | C. |
| 282 | 9 6 | +14 30 | 68 | 70 | C. |
| 283 | 9 10 | +18 30 | 61 | 64 | C. |
| 284 | 9 10 | +17 30 | 62 | 65 | C. |
| 285 | 9 10 | +16 30 | 64 | 66 | C. |
| 286 | 9 10 | +15 30 | 65 | 67 | C. |
| 287 | 9 10 | +14 30 | 63 | 65 | C. |
| 288 | 9 14 | +18 30 | 53 | 56 | C. |
| 289 | 9 14 | +17 30 | 58 | 61 | C. |
| 290 | 9 14 | +16 30 | 59 | 61 | C. |
| 291 | 9 14 | +15 30 | 61 | 63 | C. |
| 292 | 9 14 | +14 30 | 68 | 70 | C. |
| 293 | 9 18 | +18 30 | 55 | 58 | C. |
| 294 | 9 18 | +17 30 | 63 | 66 | C. |
| 295 | 9 18 | +16 30 | 53 | 55 | C. |
| 296 | 9 18 | +15 30 | 67 | 60 | C. |
| 297 | 9 18 | +14 30 | 50 | 52 | C. |
| 298 | 9 26 | +16 30 | 60 | 62 | C. |
| 299 | 9 26 | +15 30 | 62 | 64 | C. |
| 300 | 9 26 | +14 30 | 83 | 85 | C, |
| 301 | 9 26 | +13 30 | 61 | 63 | C. |
| 302 | 9 30 | +16 30 | 57 | 60 | C. |
| 303 | 9 30 | +15 30 | 57 | 60 | C. |
| 304 | 9 30 | +14 30 | 55 | 57 | C. |

TABLE I—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Star | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 305 | 9 30 | +13 30 | 63 | 65 | C. |
| 306 | 9 34 | +16 30 | 47 | 49 | C. |
| 307 | 9 34 | +15 30 | 57 | 59 | C. |
| 308 | 9 34 | +14 30 | 63 | 65 | C. |
| 309 | 9 34 | +13 30 | 58 | 60 | C. |
| 310 | 9 38 | +16 30 | 54 | 56 | C. |
| 311 | 9 38 | +15 30 | 58 | 60 | C. |
| 312 | 9 38 | +14 30 | 58 | 60 | C. |
| 313 | 9 38 | +13 30 | 63 | 65 | C. |
| 314 | 9 42 | + 9 30 | 61 | 62 | C. |
| 315 | 9 46 | +14 30 | 64 | 66 | C. |
| 316 | 9 46 | +13 30 | 78 | 80 | C. |
| 317 | 9 46 | +12 30 | 54 | 55 | C. |
| 318 | 9 46 | +11 30 | 65 | 66 | C, |
| 318*a* | 9 46 | + 9 30 | 75 | 76 | C. |
| 319 | 9 50 | +14 30 | 73 | 75 | C. |
| 320 | 9 50 | +13 30 | 66 | 68 | C. |
| 321 | 9 50 | +12 30 | 73 | 74 | C. |
| 322 | 9 50 | +11 30 | 63 | 64 | C. |
| 323 | 9 50 | +9 30 | 73 | 74 | C. |
| 324 | 9 54 | +14 30 | 80 | 82 | C. |
| 325 | 9 54 | +13 30 | 65 | 67 | C. |
| 326 | 9 54 | +12 30 | 55 | 56 | C. |
| 327 | 9 54 | +11 30 | 63 | 64 | C. |
| 328 | 9 54 | +9 30 | 59 | 60 | P. Ms. |
| 329 | 9 58 | +14 30 | 62 | 64 | C. |
| 330 | 9 58 | +13 30 | 49 | 50 | C. |
| 331 | 9 58 | +12 30 | 46 | 47 | C. |
| 332 | 9 58 | +11 30 | 69 | 70 | C. |

TABLE I—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 333 | 9 58 | + 9 30 | 71 | 72 | P. Ms. |
| 334 | 10 2 | +14 30 | 80 | 82 | P. Ms. |
| 335 | 10 2 | +13 30 | 78 | 80 | P. Ms. |
| 336 | 10 2 | +12 30 | 80 | 82 | P. Ms. |
| 337 | 10 2 | +11 30 | 82 | 84 | P. Ms. |
| 338 | 10 2 | +10 30 | 62 | 63 | P. Ms. |
| 339 | 10 6 | +14 30 | 75 | 77 | P. Ms. |
| 340 | 10 6 | +13 30 | 70 | 72 | P. Ms. |
| 341 | 10 6 | +12 30 | 93 | 95 | P. Ms. |
| 342 | 10 6 | +11 30 | 84 | 86 | P. Ms. |
| 343 | 10 6 | +10 30 | 84 | 86 | P. Ms. |
| 344 | 10 10 | +14 30 | 69 | 71 | P. Ms. |
| 345 | 10 10 | +13 30 | 91 | 94 | P. Ms. |
| 346 | 10 10 | +12 30 | 74 | 75 | P. Ms. |
| 347 | 10 10 | +11 30 | 69 | 70 | P. Ms. |
| 348 | 10 10 | +10 30 | 68 | 69 | P. Ms. |
| 349 | 10 14 | +14 30 | 67 | 69 | P. Ms. |
| 350 | 10 14 | +13 30 | 58 | 60 | P. Ms. |
| 351 | 10 14 | +12 30 | 85 | 87 | P. Ms. |
| 352 | 10 14 | +11 30 | 86 | 88 | P. Ms. |
| 353 | 10 14 | +10 30 | 61 | 62 | P. Ms. |
| 354 | 10 18 | +14 30 | 72 | 74 | P. Ms. |
| 355 | 10 18 | +13 30 | 61 | 63 | P. Ms. |
| 356 | 10 18 | +12 30 | 69 | 70 | P. Ms. |
| 357 | 10 18 | +11 30 | 85 | 87 | P. Ms. |
| 358 | 10 18 | +10 30 | 71 | 72 | P. Ms. |
| 359 | 10 22 | +14 30 | 46 | 47 | P. Ms. |
| 360 | 10 22 | +13 30 | 59 | 61 | P. Ms. |

TABLE I.— COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 361 | 10 22 | +12 30 | 47 | 48 | P. Ms. |
| 362 | 10 26 | +14 30 | 53 | 54 | P. Ms. |
| 363 | 10 26 | +13 30 | 47 | 48 | P. Ms. |
| 364 | 10 26 | +12 30 | 57 | 58 | P. Ms. |
| 365 | 10 30 | +14 30 | 50 | 51 | P. Ms. |
| 366 | 10 30 | +13 30 | 60 | 62 | P. Ms. |
| 367 | 10 30 | +12 30 | 55 | 56 | P. Ms. |
| 368 | 10 34 | +14 30 | 51 | 53 | P. Ms. |
| 369 | 10 34 | +13 30 | 71 | 73 | P. Ms. |
| 370 | 10 34 | +12 30 | 51 | 52 | P. Ms. |
| 371 | 10 38 | +14 30 | 47 | 48 | P. Ms. |
| 372 | 10 38 | +13 30 | 52 | 54 | P. Ms. |
| 373 | 10 38 | +12 30 | 64 | 65 | P. Ms. |
| 374 | 10 42 | +14 30 | 61 | 63 | P. Ms. |
| 375 | 10 42 | +13 30 | 52 | 54 | P. Ms. |
| 376 | 10 42 | +12 30 | 50 | 51 | P. Ms. |
| 377 | 10 46 | +14 30 | 69 | 71 | P. Ms. |
| 378 | 10 46 | +13 30 | 51 | 52 | P. Ms. |
| 379 | 10 46 | +12 30 | 64 | 65 | P. Ms. |
| 380 | 10 50 | +14 30 | 64 | 66 | P. Ms. |
| 381 | 10 50 | +13 30 | 66 | 67 | P. Ms. |
| 382 | 10 50 | +12 30 | 72 | 73 | P. Ms. |
| 383 | 10 54 | +14 30 | 85 | 87 | P. Ms. |
| 384 | 10 54 | +13 30 | 74 | 76 | P. Ms. |
| 385 | 10 54 | +12 30 | 73 | 74 | P. Ms. |
| 386 | 10 58 | +14 30 | 90 | 93 | P. Ms. |
| 387 | 10 58 | +13 30 | 86 | 89 | P. Ms. |
| 388 | 10 58 | +12 30 | 100 | 102 | P. Ms. |

TABLE I—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ′ ° | | | |
| 389 | 11 2 | — 0 30 | 54 | 54 | P. Ms. |
| 390 | 11 2 | — 1 30 | 56 | 56 | P. Ms. |
| 391 | 11 2 | — 2 30 | 47 | 47 | P. Ms. |
| 392 | 11 2 | — 3 30 | 58 | 58 | P. Ms. |
| 393 | 11 2 | — 4 30 | 70 | 70 | P. Ms. |
| 394 | 11 6 | + 7 30 | 46 | 46 | C. |
| 395 | 11 6 | + 6 30 | 47 | 47 | C. |
| 396 | 11 6 | + 5 30 | 51 | 51 | C. |
| 397 | 11 6 | + 4 30 | 46 | 46 | C. |
| 398 | 11 6 | + 3 30 | 51 | 51 | C. |
| 399 | 11 6 | — 0 30 | 54 | 54 | P. Ms. |
| 400 | 11 6 | — 1 30 | 64 | 64 | P. Ms. |
| 401 | 11 6 | — 2 30 | 33 | 33 | P. Ms. |
| 402 | 11 6 | — 3 30 | 68 | 68 | P. Ms. |
| 403 | 11 6 | — 4 30 | 63 | 63 | P. Ms. |
| 404 | 11 10 | + 7 30 | 46 | 46 | C. |
| 405 | 11 10 | + 6 30 | 56 | 56 | C. |
| 406 | 11 10 | + 5 30 | 57 | 57 | C. |
| 407 | 11 10 | + 4 30 | 42 | 42 | C. |
| 408 | 11 10 | + 3 30 | 53 | 53 | C. |
| 409 | 11 10 | — 0 30 | 45 | 45 | P. Ms. |
| 410 | 11 10 | — 1 30 | 56 | 56 | P. Ms. |
| 411 | 11 10 | — 2 30 | 52 | 52 | P. Ms. |
| 412 | 11 10 | — 3 30 | 75 | 75 | P. Ms. |
| 413 | 11 10 | — 4 30 | 67 | 67 | P. Ms. |
| 414 | 11 14 | + 7 30 | 50 | 50 | C. |
| 415 | 11 14 | + 6 30 | 51 | 51 | C. |
| 416 | 11 14 | + 5 30 | 76 | 76 | C. |

TABLE I—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 417 | 11 14 | + 4 30 | 49 | 49 | C. |
| 418 | 11 14 | + 3 30 | 57 | 57 | C. |
| 419 | 11 14 | — 0 30 | 45 | 45 | P. Ms. |
| 420 | 11 14 | — 1 30 | 55 | 55 | P. Ms. |
| 421 | 11 14 | — 2 30 | 55 | 55 | P. Ms. |
| 422 | 11 14 | — 3 30 | 67 | 67 | P. Ms. |
| 423 | 11 14 | — 4 30 | 76 | 76 | P. Ms. |
| 424 | 11 18 | + 7 30 | 52 | 52 | C. |
| 425 | 11 18 | + 6 30 | 50 | 50 | C. |
| 426 | 11 18 | + 5 30 | 37 | 37 | C. |
| 427 | 11 18 | + 4 30 | 52 | 52 | C. |
| 428 | 11 18 | + 3 30 | 69 | 69 | C. |
| 429 | 11 18 | — 0 30 | 46 | 46 | P. Ms. |
| 430 | 11 18 | — 1 30 | 55 | 55 | P. Ms. |
| 431 | 11 18 | — 2 30 | 54 | 54 | P. Ms. |
| 432 | 11 18 | — 3 30 | 56 | 56 | P. Ms. |
| 433 | 11 18 | — 4 30 | 57 | 57 | P. Ms. |
| 434 | 11 22 | — 0 30 | 51 | 51 | P. Ms. |
| 435 | 11 22 | — 1 30 | 53 | 53 | P. Ms. |
| 436 | 11 22 | — 2 30 | 50 | 50 | P. Ms. |
| 437 | 11 22 | — 3 30 | 58 | 58 | P. Ms. |
| 438 | 11 22 | — 4 30 | 60 | 60 | P. Ms. |
| 439 | 11 26 | + 4 30 | 62 | 62 | C. |
| 440 | 11 26 | + 3 30 | 52 | 52 | C. |
| 441 | 11 26 | + 2 30 | 57 | 57 | C. |
| 442 | 11 26 | + 1 30 | 47 | 47 | C. |
| 443 | 11 26 | — 0 30 | 66 | 66 | P. Ms. |
| 444 | 11 26 | — 1 30 | 55 | 55 | P. Ms. |

TABLE I—COUNTS OF STARS— Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 445 | 11 26 | — 2 30 | 64 | 64 | P. Ms. |
| 446 | 11 26 | — 3 30 | 57 | 57 | P. Ms. |
| 447 | 11 26 | — 4 30 | 65 | 65 | P. Ms. |
| 448 | 11 30 | + 4 30 | 55 | 55 | C. |
| 449 | 11 30 | + 3 30 | 83 | 83 | C. |
| 450 | 11 30 | + 2 30 | 85 | 85 | C. |
| 451 | 11 30 | + 1 30 | 56 | 56 | C. |
| 452 | 11 30 | — 0 30 | 51 | 51 | P. Ms. |
| 453 | 11 30 | — 1 30 | 60 | 60 | P. Ms. |
| 454 | 11 30 | — 2 30 | 58 | 58 | P. Ms. |
| 455 | 11 30 | — 3 30 | 44 | 44 | P. Ms. |
| 456 | 11 30 | — 4 30 | 45 | 45 | P. Ms. |
| 457 | 11 34 | + 4 30 | 66 | 66 | C. |
| 458 | 11 34 | + 3 30 | 79 | 79 | C. |
| 459 | 11 34 | + 2 30 | 80 | 80 | C. |
| 460 | 11 34 | + 1 30 | 42 | 42 | C. |
| 461 | 11 38 | + 4 30 | 46 | 46 | C. |
| 462 | 11 38 | + 3 30 | 51 | 51 | C. |
| 463 | 11 38 | + 2 30 | 76 | 76 | C. |
| 464 | 11 38 | + 1 30 | 63 | 63 | C. |
| 465 | 11 38 | — 0 30 | 55 | 55 | P. Ms. |
| 466 | 11 38 | — 1 30 | 46 | 46 | P. Ms. |
| 467 | 11 38 | — 2 30 | 55 | 55 | P. Ms. |
| 468 | 11 38 | — 3 30 | 57 | 57 | P. Ms. |
| 469 | 11 38 | — 4 30 | 48 | 48 | P. Ms. |
| 470 | 11 42 | + 9 30 | 46 | 46 | P. Ms. |
| 471 | 11 42 | + 8 30 | 62 | 63 | P. Ms. |
| 472 | 11 42 | + 7 30 | 67 | 68 | P. Ms. |
| 473 | 11 42 | + 6 30 | 71 | 72 | P. Ms. |

TABLE I—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 474 | 11 42 | + 5 30 | 43 | 43 | P. Ms. |
| 475 | 11 42 | — 2 30 | 58 | 58 | P. Ms. |
| 476 | 11 42 | — 3 30 | 56 | 56 | P. Ms. |
| 477 | 11 42 | — 4 30 | 57 | 57 | P. Ms. |
| 478 | 11 46 | + 9 30 | 60 | 61 | P. Ms. |
| 479 | 11 46 | + 8 30 | 58 | 59 | P. Ms. |
| 480 | 11 46 | + 7 30 | 51 | 51 | P. Ms. |
| 481 | 11 46 | + 6 30 | 64 | 64 | P. Ms. |
| 482 | 11 46 | + 5 30 | 57 | 57 | P. Ms. |
| 483 | 11 46 | + 4 30 | 78 | 78 | P. Ms. |
| 484 | 11 46 | — 2 30 | 64 | 64 | P. Ms. |
| 485 | 11 46 | — 3 30 | 52 | 52 | P. Ms. |
| 486 | 11 46 | — 4 30 | 58 | 58 | P. Ms. |
| 487 | 11 50 | + 9 30 | 56 | 57 | P. Ms. |
| 488 | 11 50 | + 8 30 | 56 | 57 | P. Ms. |
| 489 | 11 50 | + 7 30 | 45 | 45 | P. Ms. |
| 490 | 11 50 | + 6 30 | 60 | 60 | P. Ms. |
| 491 | 11 50 | + 5 30 | 62 | 62 | P. Ms. |
| 492 | 11 50 | + 4 30 | 61 | 61 | P. Ms. |
| 493 | 11 50 | — 2 30 | 42 | 42 | P. Ms. |
| 494 | 11 50 | — 3 30 | 60 | 60 | P. Ms. |
| 495 | 11 50 | — 4 30 | 55 | 55 | P. Ms. |
| 496 | 11 54 | + 9 30 | 60 | 61 | P. Ms. |
| 497 | 11 54 | + 8 30 | 62 | 63 | P. Ms. |
| 498 | 11 54 | + 7 30 | 76 | 77 | P. Ms. |
| 499 | 11 54 | + 6 30 | 63 | 63 | P. Ms. |
| 500 | 11 54 | + 5 30 | 48 | 48 | P. Ms |
| 501 | 11 54 | + 4 30 | 69 | 69 | P. Ms. |

TABLE I.—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 502 | 11 54 | — 2 30 | 56 | 56 | P. Ms. |
| 503 | 11 54 | — 3 30 | 43 | 43 | P. Ms. |
| 504 | 11 54 | — 4 30 | 45 | 45 | P. Ms. |
| 505 | 11 58 | + 9 30 | 57 | 58 | P. Ms. |
| 506 | 11 58 | + 8 30 | 60 | 61 | P. Ms. |
| 507 | 11 58 | + 7 30 | 49 | 49 | P. Ms. |
| 508 | 11 58 | + 6 30 | 70 | 71 | P. Ms. |
| 509 | 11 58 | + 5 30 | 57 | 57 | P. Ms. |
| 510 | 11 58 | + 4 30 | 55 | 55 | P. Ms. |
| 511 | 11 58 | — 2 30 | 53 | 53 | P. Ms. |
| 512 | 11 58 | — 3 30 | 53 | 53 | P. Ms. |
| 513 | 11 58 | — 4 30 | 47 | 47 | P. Ms. |
| 514 | 12 2 | + 9 30 | 58 | 59 | P. Ms. |
| 515 | 12 2 | + 8 30 | 58 | 59 | P. Ms. |
| 516 | 12 2 | + 7 30 | 66 | 67 | P. Ms. |
| 517 | 12 2 | + 6 30 | 54 | 54 | P. Ms. |
| 518 | 12 2 | + 5 30 | 52 | 52 | P. Ms. |
| 519 | 12 2 | + 4 30 | 58 | 58 | P. Ms. |
| 520 | 12 2 | + 3 30 | 70 | 70 | P. Ms. |
| 521 | 12 2 | + 2 30 | 67 | 67 | P. Ms. |
| 522 | 12 2 | + 1 30 | 57 | 57 | P. Ms. |
| 523 | 12 2 | + 0 30 | 64 | 64 | P. Ms. |
| 524 | 12 2 | — 0 30 | 52 | 52 | P. Ms. |
| 525 | 12 2 | — 1 30 | 65 | 65 | P. Ms. |
| 526 | 12 2 | — 2 30 | 51 | 51 | P. Ms. |
| 527 | 12 2 | — 3 30 | 46 | 46 | P. Ms. |
| 528 | 12 2 | — 4 30 | 54 | 54 | P. Ms. |
| 529 | 12 6 | + 9 30 | 58 | 59 | P. Ms. |

TABLE I.— COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 530 | 12 6 | + 8 30 | 58 | 59 | P. Ms. |
| 531 | 12 6 | + 7 30 | 60 | 61 | P. Ms. |
| 532 | 12 6 | + 6 30 | 69 | 69 | P. Ms. |
| 533 | 12 6 | + 5 30 | 56 | 56 | P. Ms. |
| 534 | 12 6 | + 4 30 | 52 | 52 | P. Ms. |
| 535 | 12 6 | + 3 30 | 56 | 56 | P. Ms. |
| 536 | 12 6 | + 2 30 | 56 | 56 | P. Ms. |
| 537 | 12 6 | + 1 30 | 62 | 62 | P. Ms. |
| 538 | 12 6 | + 0 30 | 57 | 57 | P. Ms. |
| 539 | 12 6 | — 0 30 | 79 | 79 | P. Ms. |
| 540 | 12 6 | — 1 30 | 56 | 56 | P. Ms. |
| 541 | 12 6 | — 2 30 | 60 | 60 | P. Ms. |
| 542 | 12 6 | — 3 30 | 46 | 46 | P. Ms. |
| 543 | 12 6 | — 4 30 | 55 | 55 | P. Ms. |
| 544 | 12 10 | + 9 30 | 67 | 68 | P. Ms. |
| 545 | 12 10 | + 8 30 | 63 | 64 | P. Ms. |
| 546 | 12 10 | + 7 30 | 69 | 70 | P. Ms, |
| 547 | 12 10 | + 6 30 | 59 | 59 | P. Ms. |
| 548 | 12 10 | + 5 30 | 74 | 74 | P. Ms. |
| 549 | 12 10 | + 4 30 | 43 | 43 | P. Ms. |
| 550 | 12 10 | + 3 30 | 59 | 59 | P. Ms. |
| 551 | 12 10 | + 2 30 | 59 | 59 | P. Ms, |
| 552 | 12 10 | + 1 30 | 58 | 58 | P. Ms. |
| 553 | 12 10 | + 0 30 | 59 | 59 | P. Ms. |
| 554 | 12 10 | — 0 30 | 71 | 71 | P. Ms. |
| 555 | 12 10 | — 1 30 | 64 | 64 | P. Ms. |
| 556 | 12 10 | — 2 30 | 54 | 54 | P. Ms. |
| 557 | 12 10 | — 3 30 | 45 | 45 | P. Ms. |

TABLE I — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 558 | 12 10 | —4 30 | 68 | 68 | P. Ms. |
| 559 | 12 14 | +9 30 | 52 | 53 | P. Ms. |
| 560 | 12 14 | +8 30 | 79 | 80 | P. Ms. |
| 561 | 12 14 | +7 30 | 58 | 59 | P. Ms. |
| 562 | 12 14 | +6 30 | 67 | 67 | P. Ms. |
| 563 | 12 14 | +5 30 | 67 | 67 | P. Ms. |
| 564 | 12 14 | +4 30 | 48 | 48 | P. Ms. |
| 565 | 12 14 | +3 30 | 45 | 45 | P. Ms. |
| 556 | 12 14 | +2 30 | 59 | 59 | P. Ms. |
| 567 | 12 14 | +1 30 | 55 | 55 | P. Ms. |
| 568 | 12 14 | +0 30 | 68 | 68 | P. Ms. |
| 569 | 12 14 | —0 30 | 61 | 61 | P. Ms. |
| 570 | 12 14 | —1 30 | 74 | 74 | P. Ms. |
| 571 | 12 14 | —2 30 | 67 | 67 | P. Ms. |
| 572 | 12 14 | —3 30 | 47 | 47 | P. Ms. |
| 573 | 12 14 | —4 30 | 55 | 55 | P. Ms. |
| 574 | 12 18 | +9 30 | 67 | 68 | P. Ms. |
| 575 | 12 18 | +8 30 | 70 | 71 | P. Ms. |
| 576 | 12 18 | +7 30 | 53 | 53 | P. Ms. |
| 577 | 12 18 | +6 30 | 67 | 67 | P. Ms. |
| 578 | 12 18 | +5 30 | 66 | 66 | P. Ms. |
| 579 | 12 18 | +4 30 | 48 | 48 | P. Ms. |
| 580 | 12 18 | +3 30 | 51 | 51 | P. Ms. |
| 581 | 12 18 | +2 30 | 48 | 48 | P. Ms. |
| 582 | 12 18 | +1 30 | 66 | 66 | P. Ms. |
| 583 | 12 18 | +0 30 | 73 | 73 | P. Ms. |
| 584 | 12 18 | —0 30 | 74 | 74 | P. Ms. |
| 585 | 12 18 | —1 30 | 61 | 61 | P. Ms. |

TABLE I—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 586 | 12 18 | — 2 30 | 52 | 52 | P. Ms. |
| 587 | 12 18 | — 3 30 | 54 | 54 | P. Ms. |
| 588 | 12 18 | — 4 30 | 58 | 58 | P. Ms. |
| 589 | 12 22 | — 0 30 | 62 | 62 | P. Ms. |
| 590 | 12 26 | — 0 30 | 63 | 63 | P. Ms. |
| 591 | 12 30 | — 0 30 | 52 | 52 | P. Ms. |
| 592 | 12 34 | — 0 30 | 53 | 53 | P. Ms. |
| 593 | 12 38 | — 0 30 | 63 | 63 | P. Ms. |
| 594 | 12 46 | + 1 30 | 50 | 50 | C. |
| 595 | 12 46 | + 0 30 | 57 | 57 | C. |
| 596 | 12 50 | + 1 30 | 57 | 57 | C. |
| 597 | 12 50 | + 0 30 | 74 | 74 | C. |
| 598 | 13 22 | — 5 30 | 55 | 55 | P. Ms. |
| 599 | 13 26 | — 5 30 | 79 | 79 | P. Ms. |
| 600 | 13 30 | — 5 30 | 76 | 76 | P. Ms. |
| 601 | 13 34 | — 5 30 | 75 | 75 | P. Ms. |
| 602 | 13 38 | — 5 30 | 65 | 65 | P. Ms. |
| 603 | 13 42 | —10 30 | 72 | 73 | P. Ms. |
| 604 | 13 42 | —11 30 | 68 | 69 | P. Ms. |
| 605 | 13 42 | —12 30 | 77 | 79 | P. Ms. |
| 606 | 13 42 | —13 30 | 62 | 64 | P. Ms. |
| 607 | 13 42 | —14 30 | 56 | 58 | P. Ms. |
| 608 | 13 46 | —10 30 | 66 | 67 | P. Ms. |
| 609 | 13 46 | —11 30 | 79 | 81 | P. Ms. |
| 610 | 13 46 | —12 30 | 71 | 73 | P. Ms. |
| 611 | 13 46 | —13 30 | 76 | 78 | P. Ms. |
| 612 | 13 46 | —14 30 | 73 | 75 | P. Ms. |
| 613 | 13 50 | —10 30 | 68 | 69 | P. Ms. |

TABLE I — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 614 | 13 50 | −11 30 | 83 | 85 | P. Ms. |
| 615 | 13 50 | −12 30 | 80 | 82 | P. Ms. |
| 616 | 13 50 | −13 30 | 75 | 77 | P. Ms. |
| 617 | 13 50 | −14 30 | 63 | 65 | P. Ms. |
| 618 | 13 54 | −10 30 | 68 | 69 | P. Ms. |
| 619 | 13 54 | −11 30 | 70 | 71 | P. Ms. |
| 620 | 13 54 | −12 30 | 73 | 74 | P. Ms. |
| 621 | 13 54 | −13 30 | 72 | 74 | P. Ms. |
| 622 | 13 54 | −14 30 | 85 | 87 | P. Ms. |
| 623 | 13 58 | −10 30 | 68 | 69 | P. Ms. |
| 624 | 13 58 | −11 30 | 74 | 75 | P. Ms. |
| 625 | 13 58 | −12 30 | 67 | 68 | P. Ms. |
| 626 | 13 58 | −13 30 | 82 | 84 | P. Ms. |
| 627 | 13 58 | −14 30 | 100 | 103 | P. Ms. |
| 628 | 14 2 | −10 30 | 85 | 87 | P. Ms. |
| 629 | 14 2 | −11 30 | 81 | 83 | P. Ms. |
| 630 | 14 2 | −12 30 | 96 | 98 | P. Ms. |
| 631 | 14 2 | −13 30 | 71 | 73 | P. Ms. |
| 632 | 14 2 | −14 30 | 88 | 90 | P. Ms. |
| 633 | 14 6 | −10 30 | 93 | 95 | P. Ms. |
| 634 | 14 6 | −11 30 | 79 | 81 | P. Ms. |
| 635 | 14 6 | −12 30 | 68 | 69 | P. Ms. |
| 636 | 14 6 | −13 30 | 83 | 85 | P. Ms. |
| 637 | 14 6 | −14 30 | 94 | 97 | P. Ms. |
| 638 | 14 10 | −10 30 | 65 | 66 | P. Ms. |
| 639 | 14 10 | −11 30 | 92 | 94 | P. Ms. |
| 640 | 14 10 | −12 30 | 76 | 78 | P. Ms. |
| 641 | 14 10 | −13 30 | 75 | 77 | P. Ms. |

TABLE I—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 642 | 14 10 | —14 30 | 77 | 79 | P. Ms. |
| 643 | 14 14 | —10 30 | 68 | 69 | P. Ms. |
| 644 | 14 14 | —11 30 | 74 | 75 | P. Ms. |
| 645 | 14 14 | —12 30 | 68 | 69 | P. Ms. |
| 646 | 14 14 | —13 30 | 71 | 73 | P. Ms. |
| 647 | 14 14 | —14 30 | 87 | 89 | P. Ms. |
| 648 | 14 18 | —10 30 | 77 | 78 | P. Ms. |
| 649 | 14 18 | —11 30 | 91 | 93 | P. Ms. |
| 650 | 14 18 | —12 30 | 96 | 98 | P. Ms. |
| 651 | 14 18 | —13 30 | 88 | 90 | P. Ms. |
| 652 | 14 18 | —14 30 | 100 | 103 | P. Ms. |
| 653 | 15 14 | —12 30 | 74 | 80 | WATSON. |
| 654 | 15 18 | —21 30 | 91 | 98 | WATSON. |
| 655 | 15 22 | —20 30 | 99 | 106 | P. Ms. |
| 656 | 15 26 | —20 30 | 88 | 94 | P. Ms. |
| 657 | 15 30 | —20 30 | 86 | 92 | P. Ms. |
| 658 | 15 34 | —20 30 | 94 | 100 | P. Ms. |
| 659 | 15 38 | —20 30 | 86 | 92 | P. Ms. |
| 660 | 15 42 | —20 30 | 100 | 107 | P. Ms. |
| 661 | 15 46 | —20 30 | 78 | 83 | P. Ms. |
| 662 | 15 50 | —20 30 | 96 | 103 | P. Ms. |
| 663 | 15 54 | —20 30 | 104 | 111 | P. Ms. |
| 664 | 15 58 | —20 30 | 100 | 107 | P. Ms. |
| 665 | 16 6 | +15 30 | 61 | 63 | WATSON. |
| 666 | 16 10 | +15 30 | 75 | 78 | WATSON. |
| 667 | 16 14 | +15 30 | 69 | 72 | WATSON. |
| 668 | 16 22 | +16 30 | 85 | 88 | WATSON. |
| 669 | 16 26 | +16 30 | 90 | 94 | WATSON. |

TABLE I—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 670 | 16 30 | +16 30 | 88 | 92 | WATSON, |
| 671 | 19 2 | —22 30 | 164 | 177 | P. Ms. |
| 672 | 19 2 | —25 30 | 174 | 193 | P. Ms. |
| 673 | 19 6 | —22 30 | 162 | 174 | P. Ms. |
| 674 | 19 6 | —25 30 | 169 | 188 | P, Ms. |
| 675 | 19 10 | —22 30 | 173 | 186 | P. Ms. |
| 676 | 19 10 | —25 30 | 169 | 188 | P. Ms. |
| 677 | 19 14 | —22 30 | 211 | 228 | P. Ms. |
| 678 | 19 14 | —25 30 | 186 | 207 | P. Ms. |
| 679 | 19 18 | —22 30 | 210 | 227 | P. Ms. |
| 680 | 19 18 | —25 30 | 212 | 235 | P. Ms. |
| 681 | 20 2 | — 5 30 | 108 | 108 | P. Ms. |
| 682 | 20 6 | — 5 30 | 106 | 106 | P. Ms. |
| 683 | 20 10 | — 5 30 | 151 | 151 | P. Ms. |
| 684 | 20 14 | — 5 30 | 158 | 158 | P. Ms. |
| 685 | 20 18 | — 5 30 | 139 | 139 | P. Ms. |
| 686 | 20 22 | — 5 30 | 122 | 122 | P. Ms. |
| 687 | 20 26 | — 5 30 | 99 | 99 | P. Ms. |
| 688 | 20 30 | — 5 30 | 82 | 82 | P. Ms. |
| 689 | 20 34 | — 5 30 | 92 | 92 | P. Ms. |
| 690 | 20 38 | — 5 30 | 90 | 90 | P. Ms. |
| 691 | 20 42 | — 5 30 | 79 | 79 | P. Ms. |
| 692 | 20 46 | — 5 30 | 86 | 86 | P. Ms. |
| 693 | 20 50 | — 5 30 | 74 | 74 | P. Ms. |
| 694 | 20 54 | — 5 30 | 66 | 66 | P. Ms. |
| 695 | 20 58 | — 5 30 | 86 | 86 | P. Ms. |
| 696 | 21 2 | —20 30 | 65 | 69 | P. Ms. |
| 697 | 21 2 | —21 30 | 85 | 91 | P. Ms. |

TABLE I — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 698 | 21 2 | —22 30 | 90 | 97 | P. Ms. |
| 699 | 21 2 | —23 30 | 81 | 88 | P. Ms. |
| 700 | 21 2 | —24 30 | 70 | 77 | P. Ms. |
| 701 | 21 2 | —25 30 | 96 | 108 | WATSON. |
| 702 | 21 6 | —20 30 | 80 | 86 | P. Ms. |
| 703 | 21 6 | —21 30 | 74 | 79 | P. Ms. |
| 704 | 21 6 | —22 30 | 85 | 92 | P. Ms. |
| 705 | 21 6 | —23 30 | 62 | 67 | P. Ms. |
| 706 | 21 6 | —24 30 | 65 | 72 | P. Ms. |
| 707 | 21 10 | —20 30 | 85 | 91 | P. Ms. |
| 708 | 21 10 | —21 30 | 85 | 91 | P. Ms. |
| 709 | 21 10 | —22 30 | 110 | 119 | P. Ms. |
| 710 | 21 10 | —23 30 | 89 | 97 | P. Ms. |
| 711 | 21 10 | —24 30 | 66 | 73 | P. Ms. |
| 712 | 21 14 | —20 30 | 79 | 84 | P. Ms. |
| 713 | 21 14 | —21 30 | 68 | 73 | P. Ms. |
| 714 | 21 14 | —22 30 | 89 | 96 | P. Ms. |
| 715 | 21 14 | —23 30 | 87 | 95 | P. Ms. |
| 716 | 21 14 | —24 30 | 48 | 53 | P. Ms. |
| 717 | 21 18 | —20 30 | 66 | 71 | P. Ms. |
| 718 | 21 18 | —21 30 | 82 | 88 | P. Ms. |
| 719 | 21 18 | —22 30 | 67 | 72 | P. Ms. |
| 720 | 21 18 | —23 30 | 50 | 55 | P. Ms. |
| 721 | 21 18 | —24 30 | 53 | 58 | P. Ms. |
| 722 | 21 22 | —11 30 | 80 | 82 | P. Ms. |
| 723 | 21 22 | —12 30 | 95 | 97 | P. Ms. |
| 724 | 21 22 | —13 30 | 85 | 87 | P. Ms. |
| 725 | 21 22 | —14 30 | 88 | 91 | P. Ms. |

TABLE I.—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 726 | 21 22 | —15 30 | 82 | 85 | P. Ms. |
| 727 | 21 22 | —16 30 | 73 | 76 | P. Ms. |
| 728 | 21 22 | —17 30 | 145 | 152 | P. Ms. |
| 729 | 21 22 | —18 30 | 84 | 88 | P. Ms. |
| 730 | 21 22 | —19 30 | 73 | 77 | P. Ms. |
| 731 | 21 26 | —10 30 | 96 | 98 | P. Ms. |
| 732 | 21 26 | —11 30 | 97 | 99 | P. Ms. |
| 733 | 21 26 | —12 30 | 90 | 92 | P. Ms. |
| 734 | 21 26 | —13 30 | 107 | 110 | P. Ms. |
| 735 | 21 26 | —14 30 | 106 | 109 | P. Ms. |
| 736 | 21 26 | —15 30 | 78 | 81 | P. Ms. |
| 737 | 21 26 | —16 30 | 68 | 71 | P. Ms. |
| 738 | 21 26 | —17 30 | 88 | 92 | P. Ms. |
| 739 | 21 26 | —18 30 | 88 | 92 | P. Ms. |
| 740 | 21 26 | —19 30 | 89 | 94 | P. Ms. |
| 741 | 21 30 | —10 30 | 94 | 96 | P. Ms. |
| 742 | 21 30 | —11 30 | 94 | 96 | P. Ms. |
| 743 | 21 30 | —12 30 | 98 | 100 | P. Ms. |
| 744 | 21 30 | —13 30 | 89 | 92 | P. Ms. |
| 745 | 21 30 | —14 30 | 106 | 109 | P. Ms. |
| 746 | 21 30 | —15 30 | 73 | 76 | P. Ms. |
| 747 | 21 30 | —16 30 | 64 | 66 | P. Ms. |
| 748 | 21 30 | —17 30 | 83 | 87 | P. Ms. |
| 749 | 21 30 | —18 30 | 79 | 83 | P. Ms. |
| 750 | 21 30 | —19 30 | 80 | 85 | P. Ms. |
| 751 | 21 34 | —10 30 | 98 | 100 | P. Ms. |
| 752 | 21 34 | —11 30 | 107 | 109 | P. Ms. |
| 753 | 21 34 | —12 30 | 92 | 94 | P. Ms. |

TABLE I—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars. Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 754 | 21 34 | —13 30 | 94 | 97 | P. Ms. |
| 755 | 21 34 | —14 30 | 95 | 98 | P. Ms. |
| 756 | 21 34 | —15 30 | 71 | 74 | P. Ms. |
| 757 | 21 34 | —16 30 | 90 | 94 | P. Ms. |
| 758 | 21 34 | —17 30 | 78 | 82 | P. Ms. |
| 759 | 21 34 | —18 30 | 73 | 77 | P. Ms. |
| 760 | 21 34 | —19 30 | 85 | 90 | P. Ms. |
| 761 | 21 38 | —10 30 | 90 | 92 | P. Ms. |
| 762 | 21 38 | —11 30 | 84 | 86 | P. Ms. |
| 763 | 21 38 | —12 30 | 77 | 79 | P. Ms. |
| 764 | 21 38 | —13 30 | 108 | 111 | P. Ms. |
| 765 | 21 38 | —14 30 | 84 | 86 | P. Ms. |
| 766 | 21 38 | —15 30 | 69 | 72 | P. Ms. |
| 767 | 21 38 | —16 30 | 80 | 83 | P. Ms. |
| 768 | 21 38 | —17 30 | 80 | 84 | P. Ms. |
| 769 | 21 38 | —18 30 | 77 | 81 | P. Ms. |
| 770 | 21 38 | —19 30 | 79 | 84 | P. Ms. |
| 771 | 21 42 | —10 30 | 91 | 93 | P. Ms. |
| 772 | 21 42 | —11 30 | 80 | 82 | P. Ms. |
| 773 | 21 42 | —12 30 | 86 | 88 | P. Ms. |
| 774 | 21 42 | —13 30 | 142 | 145 | P. Ms. |
| 775 | 21 42 | —14 30 | 92 | 95 | P. Ms. |
| 776 | 21 42 | —15 30 | 52 | 54 | P. Ms. |
| 777 | 21 42 | —16 30 | 41 | 43 | P. Ms. |
| 778 | 21 46 | —10 30 | 87 | 89 | P. Ms. |
| 779 | 21 46 | —11 30 | 82 | 84 | P. Ms. |
| 780 | 21 46 | —12 30 | 86 | 88 | P. Ms. |
| 781 | 21 46 | —13 30 | 86 | 88 | P. Ms. |

TABLE I.—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 782 | 21 46 | —14 30 | 87 | 90 | P. Ms. |
| 783 | 21 46 | —15 30 | 56 | 58 | P. Ms. |
| 784 | 21 50 | —10 30 | 88 | 90 | P. Ms. |
| 785 | 21 50 | —11 30 | 106 | 108 | P, Ms. |
| 786 | 21 50 | —12 30 | 93 | 95 | P. Ms. |
| 787 | 21 50 | —13 30 | 83 | 85 | P. Ms. |
| 788 | 21 50 | —14 30 | 82 | 84 | P. Ms. |
| 789 | 21 50 | —15 30 | 61 | 63 | P. Ms. |
| 790 | 21 54 | —10 30 | 99 | 101 | P. Ms. |
| 791 | 21 54 | —11 30 | 100 | 102 | P. Ms. |
| 792 | 21 54 | —12 30 | 105 | 107 | P. Ms. |
| 793 | 21 54 | —13 30 | 78 | 80 | P. Ms. |
| 794 | 21 54 | —14 30 | 83 | 85 | P. Ms. |
| 795 | 21 54 | —15 30 | 58 | 60 | P. Ms. |
| 796 | 21 58 | —10 30 | 83 | 85 | P. Ms. |
| 797 | 21 58 | —11 30 | 114 | 116 | P. Ms. |
| 798 | 21 58 | —12 30 | 91 | 93 | P. Ms. |
| 799 | 21 58 | —13 30 | 92 | 95 | P. Ms. |
| 800 | 21 58 | —14 30 | 79 | 81 | P. Ms. |
| 801 | 21 58 | —15 30 | 57 | 59 | P. Ms. |
| 802 | 22 2 | — 5 30 | 84 | 84 | P. Ms. |
| 803 | 22 2 | — 6 30 | 70 | 70 | P. Ms. |
| 804 | 22 2 | — 7 30 | 48 | 48 | P. Ms. |
| 805 | 22 2 | — 8 30 | 69 | 70 | P. Ms. |
| 806 | 22 2 | — 9 30 | 77 | 78 | P. Ms. |
| 807 | 22 2 | —10 30 | 83 | 85 | P. Ms. |
| 808 | 22 2 | —11 30 | 70 | 71 | P. Ms. |
| 809 | 22 2 | —12 30 | 86 | 88 | P. Ms. |

TABLE I — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 810 | 22 2 | —13 30 | 82 | 84 | P. Ms. |
| 811 | 22 2 | —14 30 | 97 | 100 | P. Ms. |
| 812 | 22 6 | — 5 30 | 94 | 94 | P. Ms. |
| 813 | 22 6 | — 6 30 | 98 | 98 | P. Ms. |
| 814 | 22 6 | — 7 30 | 57 | 57 | P. Ms. |
| 815 | 22 6 | — 8 30 | 79 | 80 | P. Ms. |
| 816 | 22 6 | — 9 30 | 91 | 92 | P. Ms. |
| 817 | 22 6 | —10 30 | 74 | 75 | P. Ms. |
| 818 | 22 6 | —11 30 | 60 | 61 | P. Ms. |
| 819 | 22 6 | —12 30 | 82 | 84 | P. Ms. |
| 820 | 22 6 | —13 30 | 89 | 92 | P. Ms. |
| 821 | 22 6 | —14 30 | 73 | 75 | P. Ms. |
| 822 | 22 10 | — 5 30 | 68 | 68 | P. Ms. |
| 823 | 22 10 | — 6 30 | 84 | 84 | P. Ms. |
| 824 | 22 10 | — 7 30 | 68 | 69 | P. Ms. |
| 825 | 22 10 | — 8 30 | 69 | 70 | P. Ms. |
| 826 | 22 10 | — 9 30 | 80 | 81 | P. Ms. |
| 827 | 22 10 | —10 30 | 65 | 66 | P. Ms. |
| 828 | 22 10 | —11 30 | 81 | 83 | P. Ms. |
| 829 | 22 10 | —12 30 | 90 | 92 | P. Ms. |
| 830 | 22 10 | —13 30 | 91 | 94 | P. Ms. |
| 831 | 22 10 | —14 30 | 87 | 90 | P. Ms. |
| 832 | 22 14 | — 5 30 | 64 | 64 | P. Ms. |
| 833 | 22 14 | — 6 30 | 67 | 67 | P. Ms. |
| 834 | 22 14 | — 7 30 | 63 | 64 | P. Ms. |
| 835 | 22 14 | — 8 30 | 67 | 68 | P. Ms. |
| 836 | 22 14 | — 9 30 | 76 | 77 | P. Ms. |
| 837 | 22 14 | —10 30 | 55 | 56 | P. Ms. |

TABLE I — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m | ° ′ | | | |
| 838 | 22 14 | —11 30 | 67 | 68 | P. Ms. |
| 839 | 22 14 | —12 30 | 75 | 76 | P. Ms. |
| 840 | 22 14 | —13 30 | 92 | 95 | P. Ms. |
| 841 | 22 14 | —14 30 | 80 | 82 | P. Ms. |
| 842 | 22 18 | — 5 30 | 85 | 85 | P. Ms. |
| 843 | 22 18 | — 6 30 | 74 | 74 | P. Ms. |
| 844 | 22 18 | — 7 30 | 84 | 85 | P. Ms. |
| 845 | 22 18 | — 8 30 | 76 | 77 | P. Ms. |
| 846 | 22 18 | — 9 30 | 68 | 69 | P. Ms. |
| 847 | 22 18 | —10 30 | 65 | 66 | P. Ms. |
| 848 | 22 18 | —11 30 | 60 | 61 | P. Ms. |
| 849 | 22 18 | —12 30 | 67 | 68 | P. Ms. |
| 850 | 22 18 | —13 30 | 84 | 86 | P. Ms. |
| 851 | 22 18 | —14 30 | 76 | 78 | P. Ms. |
| 852 | 22 22 | — 5 30 | 78 | 78 | P. Ms. |
| 853 | 22 22 | — 6 30 | 80 | 80 | P. Ms. |
| 854 | 22 22 | — 7 30 | 70 | 71 | P. Ms. |
| 855 | 22 22 | — 8 30 | 69 | 70 | P. Ms. |
| 856 | 22 22 | — 9 30 | 50 | 51 | P. Ms. |
| 857 | 22 26 | — 5 30 | 62 | 62 | P. Ms. |
| 858 | 22 26 | — 6 30 | 75 | 75 | P. Ms. |
| 859 | 22 26 | — 7 30 | 80 | 81 | P. Ms. |
| 860 | 22 26 | — 8 30 | 59 | 60 | P. Ms. |
| 861 | 22 26 | — 9 30 | 70 | 71 | P. Ms. |
| 862 | 22 30 | — 5 30 | 51 | 51 | P. Ms. |
| 863 | 22 30 | — 6 30 | 82 | 82 | P. Ms. |
| 864 | 22 30 | — 7 30 | 62 | 63 | P. Ms. |
| 865 | 22 30 | — 8 30 | 66 | 67 | P. Ms. |

TABLE I — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m | ° ′ | | | |
| 866 | 22 30 | — 9 30 | 40 | 40 | P. Ms. |
| 867 | 22 34 | — 5 30 | 67 | 67 | P. Ms. |
| 868 | 22 34 | — 6 30 | 73 | 73 | P. Ms. |
| 869 | 22 34 | — 7 30 | 70 | 71 | P. Ms. |
| 870 | 22 34 | — 8 30 | 64 | 65 | P. Ms. |
| 871 | 22 34 | — 9 30 | 54 | 55 | P. Ms. |
| 872 | 22 38 | — 5 30 | 48 | 48 | P. Ms. |
| 873 | 22 38 | — 6 30 | 50 | 50 | P. Ms. |
| 874 | 22 38 | — 7 30 | 68 | 69 | P. Ms. |
| 875 | 22 38 | — 8 30 | 64 | 65 | P. Ms. |
| 876 | 22 38 | — 9 30 | 60 | 61 | P. Ms. |
| 877 | 22 42 | — 5 30 | 54 | 54 | P. Ms. |
| 878 | 22 42 | — 6 30 | 47 | 47 | P. Ms. |
| 879 | 22 42 | — 7 30 | 62 | 63 | P. Ms. |
| 880 | 22 42 | — 8 30 | 59 | 60 | P. Ms. |
| 881 | 22 42 | — 9 30 | 65 | 66 | P. Ms. |
| 882 | 22 46 | — 5 30 | 61 | 61 | P. Ms. |
| 883 | 22 46 | — 6 30 | 52 | 52 | P. Ms. |
| 884 | 22 46 | — 7 30 | 61 | 62 | P. Ms. |
| 885 | 22 46 | — 8 30 | 55 | 56 | P. Ms. |
| 886 | 22 46 | — 9 30 | 60 | 61 | P. Ms. |
| 887 | 22 50 | — 5 30 | 52 | 52 | P. Ms. |
| 888 | 22 50 | — 6 30 | 47 | 47 | P. Ms. |
| 889 | 22 50 | — 7 30 | 72 | 73 | P. Ms. |
| 890 | 22 50 | — 8 30 | 78 | 79 | P. Ms. |
| 891 | 22 50 | — 9 30 | 66 | 67 | P. Ms. |
| 892 | 22 54 | — 5 30 | 46 | 46 | P. Ms. |
| 893 | 22 54 | — 6 30 | 61 | 61 | P. Ms. |

TABLE I — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 894 | 22 54 | — 7 30 | 63 | 64 | P. Ms. |
| 895 | 22 54 | — 8 30 | 64 | 65 | P. Ms. |
| 896 | 22 54 | — 9 30 | 72 | 73 | P. Ms. |
| 897 | 22 58 | — 5 30 | 50 | 50 | P. Ms. |
| 898 | 22 58 | — 6 30 | 60 | 60 | P. Ms. |
| 899 | 22 58 | — 7 30 | 52 | 52 | P. Ms. |
| 900 | 22 58 | — 8 30 | 60 | 61 | P. Ms. |
| 901 | 22 58 | — 9 30 | 63 | 64 | P. Ms. |
| 902 | 23 2 | + 1 30 | 71 | 71 | P. Ms. |
| 903 | 23 2 | + 0 30 | 86 | 86 | P. Ms. |
| 904 | 23 2 | — 0 30 | 66 | 66 | WATSON. |
| 905 | 23 2 | — 1 30 | 71 | 71 | WATSON. |
| 906 | 23 2 | — 6 30 | 70 | 70 | C. |
| 907 | 23 6 | + 1 30 | 93 | 93 | P. Ms. |
| 908 | 23 6 | + 0 30 | 79 | 79 | P. Ms. |
| 909 | 23 6 | — 0 30 | 64 | 64 | WATSON. |
| 910 | 23 6 | — 1 30 | 76 | 76 | WATSON. |
| 911 | 23 6 | — 5 30 | 53 | 53 | C. |
| 912 | 23 6 | — 6 30 | 55 | 55 | C. |
| 913 | 23 10 | + 1 30 | 82 | 82 | P. Ms. |
| 914 | 23 10 | + 0 30 | 85 | 85 | P. Ms. |
| 915 | 23 10 | — 4 30 | 67 | 67 | C. |
| 916 | 23 10 | — 5 30 | 53 | 53 | C. |
| 917 | 23 14 | + 0 30 | 67 | 67 | P. Ms. |
| 918 | 23 14 | — 4 30 | 65 | 65 | C. |
| 919 | 23 14 | — 5 30 | 55 | 55 | C. |
| 920 | 23 14 | — 8 30 | 56 | 57 | WATSON. |
| 921 | 23 14 | —10 30 | 61 | 62 | WATSON. |

TABLE I—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars. Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 922 | 23 18 | + 0 30 | 59 | 59 | P. Ms. |
| 923 | 23 18 | — 4 30 | 42 | 42 | C. |
| 924 | 23 18 | — 5 30 | 41 | 41 | C. |
| 925 | 23 18 | — 8 30 | 68 | 69 | WATSON. |
| 926 | 23 18 | — 9 30 | 51 | 52 | WATSON. |
| 927 | 23 18 | —10 30 | 60 | 61 | WATSON. |
| 928 | 23 22 | + 1 30 | 62 | 62 | P. Ms. |
| 929 | 23 22 | + 0 30 | 68 | 68 | P. Ms. |
| 930 | 23 22 | — 1 30 | 52 | 52 | C. |
| 931 | 23 22 | — 2 30 | 44 | 44 | C. |
| 932 | 23 22 | — 3 30 | 52 | 52 | C. |
| 933 | 23 22 | — 4 30 | 51 | 51 | C. |
| 934 | 23 26 | + 1 30 | 66 | 66 | P. Ms. |
| 935 | 23 26 | + 0 30 | 40 | 40 | P. Ms. |
| 936 | 23 26 | — 1 30 | 38 | 38 | C. |
| 937 | 23 26 | — 2 30 | 46 | 46 | C. |
| 938 | 23 26 | — 3 30 | 59 | 59 | C. |
| 939 | 23 26 | — 4 30 | 52 | 52 | C. |
| 940 | 23 30 | + 1 30 | 72 | 72 | P. Ms. |
| 941 | 23 30 | + 0 30 | 52 | 52 | P. Ms. |
| 942 | 23 30 | — 1 30 | 48 | 48 | C. |
| 943 | 23 30 | — 2 30 | 48 | 48 | C. |
| 944 | 23 30 | — 3 30 | 54 | 54 | C. |
| 945 | 23 30 | — 4 30 | 61 | 61 | C. |
| 946 | 23 34 | + 1 30 | 68 | 68 | P. Ms. |
| 947 | 23 34 | + 0 30 | 42 | 42 | P. Ms. |
| 948 | 23 34 | — 1 30 | 47 | 47 | C. |
| 949 | 23 34 | — 2 30 | 56 | 56 | C. |

TABLE I—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 950 | 23 34 | — 3 30 | 71 | 71 | C. |
| 951 | 23 34 | — 4 30 | 56 | 56 | C. |
| 952 | 23 38 | + 1 30 | 74 | 74 | P. Ms. |
| 953 | 23 38 | + 0 30 | 50 | 50 | P. Ms. |
| 954 | 23 38 | — 1 30 | 33 | 33 | C. |
| 955 | 23 38 | — 2 30 | 49 | 49 | C. |
| 956 | 23 38 | — 3 30 | 50 | 50 | C. |
| 957 | 23 38 | — 4 30 | 50 | 50 | C. |
| 958 | 23 42 | + 0 30 | 42 | 42 | C. |
| 959 | 23 42 | — 0 30 | 58 | 58 | C. |
| 960 | 23 42 | — 1 30 | 57 | 57 | C. |
| 961 | 23 42 | — 2 30 | 50 | 50 | C. |
| 962 | 23 46 | + 0 30 | 63 | 63 | C. |
| 963 | 23 46 | — 0 30 | 74 | 74 | C. |
| 964 | 23 46 | — 1 30 | 42 | 42 | C. |
| 965 | 23 46 | — 2 30 | 76 | 76 | C. |
| 966 | 23 50 | + 7 30 | 45 | 45 | WATSON. |
| 967 | 23 50 | + 6 30 | 49 | 49 | WATSON. |
| 968 | 23 50 | + 0 30 | 73 | 73 | C. |
| 969 | 23 50 | — 0 30 | 65 | 65 | C. |
| 970 | 23 50 | — 1 30 | 76 | 76 | C. |
| 971 | 23 50 | — 2 30 | 79 | 79 | C. |
| 972 | 23 54 | + 7 30 | 62 | 63 | WATSON. |
| 973 | 23 54 | + 6 30 | 62 | 62 | WATSON. |
| 974 | 23 54 | + 0 30 | 69 | 69 | C. |
| 975 | 23 54 | — 0 30 | 76 | 76 | C. |
| 976 | 23 54 | — 1 30 | 57 | 57 | C. |
| 977 | 23 54 | — 2 30 | 57 | 57 | C. |

TABLE I — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. $\delta$ | Authority. |
|---|---|---|---|---|---|
| | h. m. | ° ′ | | | |
| 978 | 23 58 | + 7 30 | 53 | 53 | WATSON. |
| 979 | 23 58 | + 6 30 | 61 | 61 | WATSON. |
| 980 | 23 58 | + 0 30 | 65 | 65 | C. |
| 981 | 23 58 | — 0 30 | 62 | 62 | C. |
| 982 | 23 58 | — 1 30 | 52 | 52 | C. |
| 983 | 23 58 | — 2 30 | 48 | 48 | C. |

TABLE II.—COUNTS OF STARS FROM THE PUBLISHED CHARTS OF DR. C. H. F. PETERS. NOS. 1-20.

| No. | R. A. 1860. | | Dec. 1860. | | No. Stars. | No. Stars Sec. $\delta$ | No. | R. A. 1860. | | Dec. 1860. | | No. Stars. | No. Stars Sec. $\delta$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h. | m. | ° | ′ | | | | h. | m. | ° | ′ | | |
| 1 | 1 | 2 | +14 | 30 | 86 | 88 | 26 | 1 | 10 | + 4 | 30 | 76 | 76 |
| 2 | 1 | 2 | +13 | 30 | 88 | 90 | 27 | 1 | 10 | + 3 | 30 | 84 | 84 |
| 3 | 1 | 2 | +12 | 30 | 74 | 76 | 28 | 1 | 10 | + 2 | 30 | 83 | 83 |
| 4 | 1 | 2 | +11 | 30 | 84 | 86 | 29 | 1 | 10 | + 1 | 30 | 78 | 78 |
| 5 | 1 | 2 | +10 | 30 | 83 | 85 | 30 | 1 | 10 | + 0 | 30 | 72 | 72 |
| 6 | 1 | 2 | + 4 | 30 | 85 | 85 | 31 | 1 | 14 | +14 | 30 | 97 | 100 |
| 7 | 1 | 2 | + 3 | 30 | 79 | 79 | 32 | 1 | 14 | +13 | 30 | 99 | 102 |
| 8 | 1 | 2 | + 2 | 30 | 77 | 77 | 33 | 1 | 14 | +12 | 30 | 78 | 79 |
| 9 | 1 | 2 | + 1 | 30 | 75 | 75 | 34 | 1 | 14 | +11 | 30 | 88 | 90 |
| 10 | 1 | 2 | + 0 | 30 | 91 | 91 | 35 | 1 | 14 | +10 | 30 | 82 | 83 |
| 11 | 1 | 6 | +14 | 30 | 93 | 96 | 36 | 1 | 14 | + 4 | 30 | 89 | 89 |
| 12 | 1 | 6 | +13 | 30 | 98 | 101 | 37 | 1 | 14 | + 3 | 30 | 88 | 88 |
| 13 | 1 | 6 | +12 | 30 | 86 | 88 | 38 | 1 | 14 | + 2 | 30 | 77 | 77 |
| 14 | 1 | 6 | +11 | 30 | 76 | 78 | 39 | 1 | 14 | + 1 | 30 | 79 | 79 |
| 15 | 1 | 6 | +10 | 30 | 88 | 90 | 40 | 1 | 14 | + 0 | 30 | 61 | 61 |
| 16 | 1 | 6 | + 4 | 30 | 109 | 109 | 41 | 1 | 18 | +14 | 30 | 79 | 81 |
| 17 | 1 | 6 | + 3 | 30 | 86 | 86 | 42 | 1 | 18 | +13 | 30 | 93 | 96 |
| 18 | 1 | 6 | + 2 | 30 | 86 | 86 | 43 | 1 | 18 | +12 | 30 | 90 | 92 |
| 19 | 1 | 6 | + 1 | 30 | 75 | 75 | 44 | 1 | 18 | +11 | 30 | 86 | 88 |
| 20 | 1 | 6 | + 0 | 30 | 77 | 77 | 45 | 1 | 18 | +10 | 30 | 88 | 90 |
| 21 | 1 | 10 | +14 | 30 | 83 | 85 | 46 | 1 | 18 | + 4 | 30 | 87 | 87 |
| 22 | 1 | 10 | +13 | 30 | 90 | 93 | 47 | 1 | 18 | + 3 | 30 | 89 | 89 |
| 23 | 1 | 10 | +12 | 30 | 94 | 96 | 48 | 1 | 18 | + 2 | 30 | 81 | 81 |
| 24 | 1 | 10 | +11 | 30 | 76 | 77 | 49 | 1 | 18 | + 1 | 30 | 76 | 76 |
| 25 | 1 | 10 | +10 | 30 | 99 | 101 | 50 | 1 | 18 | + 0 | 30 | 92 | 92 |

TABLE II.— COUNTS OF STARS — Continued.

| No. | R. A. 1860. | | Dec. 1860. | | No. Stars. | No. Stars Sec. δ | No. | R. A. 1860. | | Dec. 1860. | | No. Stars. | No. Stars Sec. δ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h. | m. | ° | ′ | | | | h. | m. | ° | ′ | | |
| 51 | 3 | 2 | +19 | 30 | 99 | 105 | 78 | 10 | 2 | +12 | 30 | 85 | 87 |
| 52 | 3 | 2 | +18 | 30 | 119 | 125 | 79 | 10 | 2 | +11 | 30 | 78 | 80 |
| 53 | 3 | 2 | +17 | 30 | 101 | 106 | 80 | 10 | 2 | +10 | 30 | 68 | 69 |
| 54 | 3 | 2 | +16 | 30 | 106 | 110 | 81 | 10 | 6 | +14 | 30 | 87 | 90 |
| 55 | 3 | 2 | +15 | 30 | 104 | 108 | 82 | 10 | 6 | +13 | 30 | 75 | 77 |
| 56 | 3 | 6 | +19 | 30 | 90 | 95 | 83 | 10 | 6 | +12 | 30 | 97 | 99 |
| 57 | 3 | 6 | +18 | 30 | 110 | 116 | 84 | 10 | 6 | +11 | 30 | 84 | 86 |
| 58 | 3 | 6 | +17 | 30 | 117 | 123 | 85 | 10 | 6 | +10 | 30 | 83 | 85 |
| 59 | 3 | 6 | +16 | 30 | 93 | 97 | 86 | 10 | 10 | +14 | 30 | 70 | 72 |
| 60 | 3 | 6 | +15 | 30 | 99 | 103 | 87 | 10 | 10 | +13 | 30 | 96 | 99 |
| 61 | 3 | 10 | +19 | 30 | 110 | 117 | 88 | 10 | 10 | +12 | 30 | 74 | 75 |
| 62 | 3 | 10 | +18 | 30 | 123 | 129 | 89 | 10 | 10 | +11 | 30 | 73 | 74 |
| 63 | 3 | 10 | +17 | 30 | 107 | 112 | 90 | 10 | 10 | +10 | 30 | 71 | 72 |
| 64 | 3 | 10 | +16 | 30 | 109 | 113 | 91 | 10 | 14 | +14 | 30 | 71 | 73 |
| 65 | 3 | 10 | +15 | 30 | 106 | 109 | 92 | 10 | 14 | +13 | 30 | 61 | 63 |
| 66 | 3 | 14 | +19 | 30 | 105 | 111 | 93 | 10 | 14 | +12 | 30 | 90 | 92 |
| 67 | 3 | 14 | +18 | 30 | 107 | 112 | 94 | 10 | 14 | +11 | 30 | 86 | 88 |
| 68 | 3 | 14 | +17 | 30 | 104 | 109 | 95 | 10 | 14 | +10 | 30 | 64 | 65 |
| 69 | 3 | 14 | +16 | 30 | 118 | 122 | 96 | 10 | 18 | +14 | 30 | 76 | 78 |
| 70 | 3 | 14 | +15 | 30 | 99 | 103 | 97 | 10 | 18 | +13 | 30 | 78 | 80 |
| 71 | 3 | 18 | +19 | 30 | 117 | 124 | 98 | 10 | 18 | +12 | 30 | 72 | 73 |
| 72 | 3 | 18 | +18 | 30 | 102 | 107 | 99 | 10 | 18 | +11 | 30 | 98 | 100 |
| 73 | 3 | 18 | +17 | 30 | 112 | 118 | 100 | 10 | 18 | +10 | 30 | 80 | 82 |
| 74 | 3 | 18 | +16 | 30 | 114 | 118 | 101 | 10 | 22 | +14 | 30 | 74 | 76 |
| 75 | 3 | 18 | +15 | 30 | 104 | 108 | 102 | 10 | 22 | +13 | 30 | 85 | 87 |
| 76 | 10 | 2 | +14 | 30 | 81 | 83 | 103 | 10 | 22 | +12 | 30 | 75 | 76 |
| 77 | 10 | 2 | +13 | 30 | 87 | 89 | 104 | 10 | 22 | +11 | 30 | 72 | 73 |

TABLE II—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | | Dec. 1860. | | No. Stars. | No. Stars Sec. $\delta$ | No. | R. A. 1860. | | Dec. 1860. | | No. Stars. | No. Stars Sec. $\delta$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h. | m. | ° | ′ | | | | h. | m. | ° | ′ | | |
| 105 | 10 | 22 | +10 | 30 | 82 | 83 | 132 | 10 | 46 | +13 | 30 | 63 | 65 |
| 106 | 10 | 26 | +14 | 30 | 93 | 96 | 133 | 10 | 46 | +12 | 30 | 84 | 86 |
| 107 | 10 | 26 | +13 | 30 | 67 | 69 | 134 | 10 | 46 | +11 | 30 | 94 | 96 |
| 108 | 10 | 26 | +12 | 30 | 84 | 86 | 135 | 10 | 46 | +10 | 30 | 81 | 83 |
| 109 | 10 | 26 | +11 | 30 | 81 | 83 | 136 | 10 | 50 | +14 | 30 | 70 | 72 |
| 110 | 10 | 26 | +10 | 30 | 84 | 86 | 137 | 10 | 50 | +13 | 30 | 73 | 75 |
| 111 | 10 | 30 | +14 | 30 | 78 | 80 | 138 | 10 | 50 | +12 | 30 | 79 | 81 |
| 112 | 10 | 30 | +13 | 30 | 87 | 89 | 138 | 10 | 50 | +11 | 30 | 72 | 73 |
| 113 | 10 | 30 | +12 | 30 | 83 | 85 | 140 | 10 | 50 | +10 | 30 | 65 | 66 |
| 114 | 10 | 30 | +11 | 30 | 86 | 88 | 141 | 10 | 54 | +14 | 30 | 81 | 83 |
| 115 | 10 | 30 | +10 | 30 | 81 | 82 | 142 | 10 | 54 | +13 | 30 | 78 | 80 |
| 116 | 10 | 34 | +14 | 30 | 85 | 87 | 143 | 10 | 54 | +12 | 30 | 81 | 83 |
| 117 | 10 | 34 | +13 | 30 | 81 | 93 | 144 | 10 | 54 | +11 | 30 | 75 | 76 |
| 118 | 10 | 34 | +12 | 30 | 78 | 80 | 145 | 10 | 54 | +10 | 30 | 73 | 74 |
| 119 | 10 | 34 | +11 | 30 | 86 | 88 | 146 | 10 | 58 | +14 | 30 | 90 | 92 |
| 120 | 10 | 34 | +10 | 30 | 92 | 94 | 147 | 10 | 58 | +13 | 30 | 97 | 100 |
| 121 | 10 | 38 | +14 | 30 | 73 | 75 | 148 | 10 | 58 | +12 | 30 | 95 | 97 |
| 122 | 10 | 38 | +13 | 30 | 83 | 85 | 149 | 10 | 58 | +11 | 30 | 66 | 67 |
| 123 | 10 | 38 | +12 | 30 | 83 | 85 | 150 | 10 | 58 | +10 | 30 | 78 | 79 |
| 124 | 10 | 38 | +11 | 30 | 77 | 78 | 151 | 11 | 2 | — 0 | 30 | 67 | 67 |
| 125 | 10 | 38 | +10 | 30 | 76 | 77 | 152 | 11 | 2 | — 1 | 30 | 64 | 64 |
| 126 | 10 | 42 | +14 | 30 | 77 | 79 | 153 | 11 | 2 | — 2 | 30 | 60 | 60 |
| 127 | 10 | 42 | +13 | 30 | 69 | 71 | 154 | 11 | 2 | — 3 | 30 | 65 | 65 |
| 128 | 10 | 42 | +12 | 30 | 63 | 64 | 155 | 11 | 2 | — 4 | 30 | 74 | 74 |
| 129 | 10 | 42 | +11 | 30 | 73 | 74 | 156 | 11 | 6 | — 0 | 30 | 78 | 78 |
| 130 | 10 | 42 | +10 | 30 | 67 | 68 | 157 | 11 | 6 | — 1 | 30 | 86 | 86 |
| 131 | 10 | 46 | +14 | 30 | 89 | 91 | 158 | 11 | 6 | — 2 | 30 | 62 | 62 |

TABLE II—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | | Dec. 1860. | | No. Stars. | No. Stars, Sec. δ | No. | R. A. 1860. | | Dec. 1860. | | No. Stars. | No. Stars, Sec. δ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h. | m. | ° | ′ | | | | h. | m. | ° | ′ | | |
| 159 | 11 | 6 | −3 | 30 | 66 | 66 | 186 | 11 | 50 | +9 | 30 | 71 | 72 |
| 160 | 11 | 6 | −4 | 30 | 66 | 66 | 187 | 11 | 50 | +8 | 30 | 71 | 72 |
| 161 | 11 | 10 | −0 | 30 | 64 | 64 | 188 | 11 | 50 | +7 | 30 | 68 | 69 |
| 162 | 11 | 10 | −1 | 30 | 76 | 76 | 189 | 11 | 50 | +6 | 30 | 75 | 75 |
| 163 | 11 | 10 | −2 | 30 | 78 | 78 | 190 | 11 | 50 | +5 | 30 | 81 | 81 |
| 164 | 11 | 10 | −3 | 30 | 76 | 76 | 191 | 11 | 54 | +9 | 30 | 67 | 68 |
| 165 | 11 | 10 | −4 | 30 | 71 | 71 | 192 | 11 | 54 | +8 | 30 | 75 | 76 |
| 166 | 11 | 14 | −0 | 30 | 60 | 60 | 193 | 11 | 54 | +7 | 30 | 85 | 86 |
| 167 | 11 | 14 | −1 | 30 | 78 | 78 | 194 | 11 | 54 | +6 | 30 | 84 | 84 |
| 168 | 11 | 14 | −2 | 30 | 73 | 73 | 195 | 11 | 54 | +5 | 30 | 67 | 67 |
| 169 | 11 | 14 | −3 | 30 | 75 | 75 | 196 | 11 | 58 | +9 | 30 | 67 | 68 |
| 170 | 11 | 14 | −4 | 30 | 81 | 81 | 197 | 11 | 58 | +8 | 30 | 66 | 67 |
| 171 | 11 | 18 | −0 | 30 | 68 | 68 | 198 | 11 | 58 | +7 | 30 | 60 | 61 |
| 172 | 11 | 18 | −1 | 30 | 71 | 71 | 199 | 11 | 58 | +6 | 30 | 81 | 81 |
| 173 | 11 | 18 | −2 | 30 | 68 | 68 | 200 | 11 | 58 | +5 | 30 | 76 | 76 |
| 174 | 11 | 18 | −3 | 30 | 59 | 59 | 201 | 12 | 2 | +9 | 30 | 59 | 60 |
| 175 | 11 | 18 | −4 | 30 | 63 | 63 | 202 | 12 | 2 | +8 | 30 | 64 | 65 |
| 176 | 11 | 42 | +9 | 30 | 61 | 62 | 203 | 12 | 2 | +7 | 30 | 81 | 82 |
| 177 | 11 | 42 | +8 | 30 | 79 | 80 | 204 | 12 | 2 | +6 | 30 | 60 | 60 |
| 178 | 11 | 42 | +7 | 30 | 81 | 82 | 205 | 12 | 2 | +5 | 30 | 61 | 61 |
| 179 | 11 | 42 | +6 | 30 | 91 | 92 | 206 | 12 | 2 | −0 | 30 | 54 | 54 |
| 180 | 11 | 42 | +5 | 30 | 53 | 53 | 207 | 12 | 2 | −1 | 30 | 75 | 75 |
| 181 | 11 | 46 | +9 | 30 | 76 | 77 | 208 | 12 | 2 | −2 | 30 | 63 | 63 |
| 182 | 11 | 46 | +8 | 30 | 77 | 78 | 209 | 12 | 2 | −3 | 30 | 55 | 55 |
| 183 | 11 | 46 | +7 | 30 | 65 | 66 | 210 | 12 | 2 | −4 | 30 | 61 | 61 |
| 184 | 11 | 46 | +6 | 30 | 74 | 74 | 211 | 12 | 6 | +9 | 30 | 58 | 59 |
| 185 | 11 | 46 | +5 | 30 | 81 | 81 | 212 | 12 | 6 | +8 | 30 | 66 | 67 |

TABLE II.—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | | Dec. 1860. | | No. Stars. | No. Stars Sec. δ | No. | R. A. 1860. | | Dec. 1860. | | No. Stars. | No. Stars Sec. δ. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h. | m. | ° | ′ | | | | h. | m. | ° | ′ | | |
| 213 | 12 | 6 | + 7 | 30 | 75 | 76 | 240 | 12 | 14 | — 4 | 30 | 56 | 56 |
| 214 | 12 | 6 | + 6 | 30 | 87 | 88 | 241 | 12 | 18 | + 9 | 30 | 66 | 67 |
| 215 | 12 | 6 | + 5 | 30 | 67 | 67 | 242 | 12 | 18 | + 8 | 30 | 68 | 69 |
| 216 | 12 | 6 | — 0 | 30 | 84 | 84 | 243 | 12 | 18 | + 7 | 30 | 70 | 71 |
| 217 | 12 | 6 | — 1 | 30 | 59 | 59 | 244 | 12 | 18 | + 6 | 30 | 75 | 75 |
| 218 | 12 | 6 | — 2 | 30 | 69 | 69 | 245 | 12 | 18 | + 5 | 30 | 68 | 68 |
| 219 | 12 | 6 | — 3 | 30 | 53 | 53 | 246 | 12 | 18 | — 0 | 30 | 76 | 76 |
| 220 | 12 | 6 | — 4 | 30 | 58 | 58 | 247 | 12 | 18 | — 1 | 30 | 67 | 67 |
| 221 | 12 | 10 | + 9 | 30 | 65 | 66 | 248 | 12 | 18 | — 2 | 30 | 71 | 71 |
| 222 | 12 | 10 | + 8 | 30 | 69 | 70 | 249 | 12 | 18 | — 3 | 30 | 77 | 77 |
| 223 | 12 | 10 | + 7 | 30 | 73 | 74 | 250 | 12 | 18 | — 4 | 30 | 80 | 80 |
| 224 | 12 | 10 | + 6 | 30 | 69 | 69 | 251 | 12 | 22 | — 0 | 30 | 72 | 72 |
| 225 | 12 | 10 | + 5 | 30 | 77 | 77 | 252 | 12 | 22 | — 1 | 30 | 79 | 79 |
| 226 | 12 | 10 | — 0 | 30 | 74 | 74 | 253 | 12 | 22 | — 2 | 30 | 64 | 64 |
| 227 | 12 | 10 | — 1 | 30 | 70 | 70 | 254 | 12 | 22 | — 3 | 30 | 80 | 80 |
| 228 | 12 | 10 | — 2 | 30 | 67 | 67 | 255 | 12 | 22 | — 4 | 30 | 67 | 67 |
| 229 | 12 | 10 | — 3 | 30 | 58 | 58 | 256 | 12 | 26 | — 0 | 30 | 72 | 72 |
| 230 | 12 | 10 | — 4 | 30 | 76 | 76 | 257 | 12 | 26 | — 1 | 30 | 70 | 70 |
| 231 | 12 | 14 | + 9 | 30 | 55 | 56 | 258 | 12 | 26 | — 2 | 30 | 54 | 54 |
| 232 | 12 | 14 | + 8 | 30 | 86 | 87 | 259 | 12 | 26 | — 3 | 30 | 63 | 63 |
| 233 | 12 | 14 | + 7 | 30 | 76 | 77 | 260 | 12 | 26 | — 4 | 30 | 60 | 60 |
| 234 | 12 | 14 | + 6 | 30 | 74 | 74 | 261 | 12 | 30 | — 0 | 30 | 61 | 61 |
| 235 | 12 | 14 | + 5 | 30 | 66 | 66 | 262 | 12 | 30 | — 1 | 30 | 79 | 79 |
| 236 | 12 | 14 | — 0 | 30 | 63 | 63 | 263 | 12 | 30 | — 2 | 30 | 100 | 100 |
| 237 | 12 | 14 | — 1 | 30 | 79 | 79 | 264 | 12 | 30 | — 3 | 30 | 55 | 55 |
| 238 | 12 | 14 | — 2 | 30 | 83 | 83 | 265 | 12 | 30 | — 4 | 30 | 73 | 73 |
| 239 | 12 | 14 | — 3 | 30 | 79 | 79 | 266 | 12 | 34 | — 0 | 30 | 56 | 56 |

TABLE II.—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | | Dec. 1860. | | No. Stars. | No. Stars Sec. δ | No. | R. A. 1860. | | Dec. 1860. | | No. Stars. | No. Stars Sec. δ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h. | m. | ° | ′ | | | | h. | m. | ° | ′ | | |
| 267 | 12 | 34 | — 1 | 30 | 76 | 76 | 294 | 14 | 14 | —13 | 30 | 76 | 78 |
| 268 | 12 | 34 | — 2 | 30 | 64 | 64 | 295 | 14 | 14 | —14 | 30 | 86 | 88 |
| 269 | 12 | 34 | — 3 | 30 | 68 | 68 | 296 | 14 | 18 | —10 | 30 | 79 | 81 |
| 270 | 12 | 34 | — 4 | 30 | 77 | 77 | 297 | 14 | 18 | —11 | 30 | 92 | 94 |
| 271 | 12 | 38 | — 0 | 30 | 73 | 73 | 298 | 14 | 18 | —12 | 30 | 99 | 101 |
| 272 | 12 | 38 | — 1 | 30 | 65 | 65 | 299 | 14 | 18 | —13 | 30 | 106 | 109 |
| 273 | 12 | 38 | — 2 | 30 | 74 | 74 | 300 | 14 | 18 | —14 | 30 | 109 | 112 |
| 274 | 12 | 38 | — 3 | 30 | 70 | 70 | 301 | 21 | 2 | —20 | 30 | 89 | 95 |
| 275 | 12 | 38 | — 4 | 30 | 70 | 70 | 302 | 21 | 2 | —21 | 30 | 109 | 117 |
| 276 | 14 | 2 | —10 | 30 | 101 | 103 | 303 | 21 | 2 | —22 | 30 | 105 | 113 |
| 277 | 14 | 2 | —11 | 30 | 92 | 94 | 304 | 21 | 2 | —23 | 30 | 87 | 95 |
| 278 | 14 | 2 | —12 | 30 | 106 | 108 | 305 | 21 | 2 | —24 | 30 | 74 | 81 |
| 279 | 14 | 2 | —13 | 30 | 78 | 80 | 306 | 21 | 6 | —20 | 30 | 100 | 107 |
| 280 | 14 | 2 | —14 | 30 | 102 | 105 | 307 | 21 | 6 | —21 | 30 | 93 | 99 |
| 281 | 14 | 6 | —10 | 30 | 103 | 105 | 308 | 21 | 6 | —22 | 30 | 93 | 100 |
| 282 | 14 | 6 | —11 | 30 | 86 | 88 | 309 | 21 | 6 | —23 | 30 | 90 | 98 |
| 283 | 14 | 6 | —12 | 30 | 97 | 99 | 310 | 21 | 6 | —24 | 30 | 82 | 90 |
| 284 | 14 | 6 | —13 | 30 | 90 | 92 | 311 | 21 | 10 | —20 | 30 | 95 | 102 |
| 285 | 14 | 6 | —14 | 30 | 101 | 104 | 312 | 21 | 10 | —21 | 30 | 94 | 100 |
| 286 | 14 | 10 | —10 | 30 | 77 | 79 | 313 | 21 | 10 | —22 | 30 | 108 | 115 |
| 287 | 14 | 10 | —11 | 30 | 101 | 103 | 314 | 21 | 10 | —23 | 30 | 96 | 104 |
| 288 | 14 | 10 | —12 | 30 | 79 | 81 | 315 | 21 | 10 | —24 | 30 | 99 | 109 |
| 289 | 14 | 10 | —13 | 30 | 104 | 107 | 316 | 21 | 14 | —20 | 30 | 89 | 96 |
| 290 | 14 | 10 | —14 | 30 | 84 | 86 | 317 | 21 | 14 | —21 | 30 | 83 | 89 |
| 291 | 14 | 14 | —10 | 30 | 80 | 82 | 318 | 21 | 14 | —22 | 30 | 94 | 101 |
| 292 | 14 | 14 | —11 | 30 | 75 | 77 | 319 | 21 | 14 | —23 | 30 | 102 | 111 |
| 293 | 14 | 14 | —12 | 30 | 78 | 80 | 320 | 21 | 14 | —24 | 30 | 96 | 106 |

TABLE II — COUNTS OF STARS — Continued.

| No. | R. A. 1860 | | Dec. 1860. | | No. Stars. | No. Stars Sec. $\delta$ | No. | R. A. 1860. | | Dec. 1860. | | No. Stars. | No. Stars Sec. $\delta$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h. | m. | ° | ′ | | | | h. | m. | ° | ′ | | |
| 321 | 21 | 18 | —20 | 30 | 79 | 85 | 348 | 21 | 30 | —12 | 30 | 99 | 101 |
| 322 | 21 | 18 | —21 | 30 | 94 | 102 | 349 | 21 | 30 | —13 | 30 | 103 | 106 |
| 323 | 21 | 18 | —22 | 30 | 78 | 84 | 350 | 21 | 30 | —14 | 30 | 105 | 108 |
| 324 | 21 | 18 | —23 | 30 | 86 | 94 | 351 | 21 | 30 | —15 | 30 | 95 | 99 |
| 325 | 21 | 18 | —24 | 30 | 91 | 100 | 352 | 21 | 30 | —16 | 30 | 96 | 100 |
| 326 | 21 | 22 | —10 | 30 | 119 | 121 | 353 | 21 | 30 | —17 | 30 | 99 | 108 |
| 327 | 21 | 22 | —11 | 30 | 84 | 86 | 354 | 21 | 30 | —18 | 30 | 90 | 95 |
| 328 | 21 | 22 | —12 | 30 | 109 | 111 | 355 | 21 | 30 | —19 | 30 | 103 | 109 |
| 329 | 21 | 22 | —13 | 30 | 95 | 98 | 356 | 21 | 34 | —10 | 30 | 98 | 100 |
| 330 | 21 | 22 | —14 | 30 | 100 | 103 | 357 | 21 | 34 | —11 | 30 | 120 | 122 |
| 331 | 21 | 22 | —15 | 30 | 93 | 97 | 358 | 21 | 34 | —12 | 30 | 101 | 103 |
| 332 | 21 | 22 | —16 | 30 | 96 | 100 | 359 | 21 | 34 | —13 | 30 | 99 | 102 |
| 333 | 21 | 22 | —17 | 30 | 142 | 149 | 360 | 21 | 34 | —14 | 30 | 106 | 109 |
| 334 | 21 | 22 | —18 | 30 | 89 | 93 | 261 | 21 | 34 | —15 | 30 | 93 | 97 |
| 335 | 21 | 22 | —19 | 30 | 83 | 88 | 362 | 21 | 34 | —16 | 30 | 116 | 120 |
| 336 | 21 | 26 | —10 | 30 | 100 | 102 | 363 | 21 | 34 | —17 | 30 | 98 | 103 |
| 337 | 21 | 26 | —11 | 30 | 108 | 110 | 364 | 21 | 34 | —18 | 30 | 109 | 114 |
| 338 | 21 | 26 | —12 | 30 | 114 | 116 | 365 | 21 | 34 | —19 | 30 | 106 | 112 |
| 339 | 21 | 26 | —13 | 30 | 112 | 115 | 366 | 21 | 38 | —10 | 30 | 105 | 107 |
| 340 | 21 | 26 | —14 | 30 | 116 | 119 | 367 | 21 | 38 | —11 | 30 | 109 | 111 |
| 341 | 21 | 26 | —15 | 30 | 101 | 105 | 368 | 21 | 38 | —12 | 30 | 104 | 106 |
| 342 | 21 | 26 | —16 | 30 | 101 | 105 | 389 | 21 | 38 | —13 | 30 | 118 | 121 |
| 343 | 21 | 26 | —17 | 30 | 97 | 102 | 370 | 21 | 38 | —14 | 30 | 91 | 94 |
| 344 | 21 | 26 | —18 | 30 | 110 | 116 | 371 | 21 | 38 | —15 | 30 | 97 | 101 |
| 345 | 21 | 26 | —19 | 30 | 113 | 123 | 372 | 21 | 38 | —16 | 30 | 108 | 112 |
| 346 | 21 | 30 | —10 | 30 | 107 | 109 | 373 | 21 | 38 | —17 | 30 | 103 | 108 |
| 347 | 21 | 30 | —11 | 30 | 103 | 105 | 374 | 21 | 38 | —18 | 30 | 107 | 112 |

TABLE II—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | | Dec. 1860. | | No. Stars. | No. Stars. Sec. δ | No. | R. A. 1860. | | Dec. 1860. | | No. Stars. | No. Stars Sec. δ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h. | m. | ° | ′ | | | | h. | m. | ° | ′ | | |
| 375 | 21 | 38 | —19 | 30 | 93 | 98 | 402 | 21 | 50 | —16 | 30 | 86 | 89 |
| 375 | 21 | 42 | —10 | 30 | 100 | 102 | 403 | 21 | 50 | —17 | 30 | 79 | 83 |
| 377 | 21 | 42 | —11 | 30 | 82 | 84 | 404 | 21 | 50 | —18 | 30 | 98 | 103 |
| 378 | 21 | 42 | —12 | 30 | 92 | 94 | 405 | 21 | 50 | —19 | 30 | 100 | 106 |
| 379 | 21 | 42 | —13 | 30 | 132 | 135 | 406 | 21 | 54 | —10 | 30 | 97 | 99 |
| 380 | 21 | 42 | —14 | 30 | 96 | 99 | 407 | 21 | 54 | —11 | 30 | 99 | 101 |
| 381 | 21 | 42 | —15 | 30 | 80 | 83 | 408 | 21 | 54 | —12 | 30 | 110 | 112 |
| 382 | 21 | 42 | —16 | 30 | 95 | 99 | 409 | 21 | 54 | —13 | 30 | 93 | 96 |
| 383 | 21 | 42 | —17 | 30 | 92 | 97 | 410 | 21 | 54 | —14 | 30 | 102 | 105 |
| 384 | 21 | 42 | —18 | 30 | 114 | 120 | 411 | 21 | 54 | —15 | 30 | 93 | 97 |
| 385 | 21 | 42 | —19 | 30 | 98 | 104 | 412 | 21 | 54 | —16 | 30 | 99 | 103 |
| 386 | 21 | 46 | —10 | 30 | 101 | 103 | 413 | 21 | 54 | —17 | 30 | 95 | 100 |
| 387 | 21 | 46 | —11 | 30 | 90 | 92 | 414 | 21 | 54 | —18 | 30 | 106 | 111 |
| 388 | 21 | 46 | —12 | 30 | 91 | 93 | 415 | 21 | 54 | —19 | 30 | 98 | 104 |
| 389 | 21 | 46 | —13 | 30 | 107 | 110 | 416 | 21 | 58 | —10 | 30 | 87 | 89 |
| 390 | 21 | 46 | —14 | 30 | 89 | 92 | 417 | 21 | 58 | —11 | 30 | 97 | 99 |
| 391 | 21 | 46 | —15 | 30 | 88 | 91 | 418 | 21 | 58 | —12 | 30 | 103 | 105 |
| 392 | 21 | 46 | —16 | 30 | 99 | 103 | 419 | 21 | 58 | —13 | 30 | 92 | 95 |
| 393 | 21 | 46 | —17 | 30 | 100 | 105 | 420 | 21 | 58 | —14 | 30 | 91 | 94 |
| 394 | 21 | 46 | —18 | 30 | 95 | 100 | 421 | 21 | 58 | —15 | 30 | 75 | 78 |
| 395 | 21 | 46 | —19 | 30 | 89 | 94 | 422 | 21 | 58 | —16 | 30 | 112 | 116 |
| 396 | 21 | 50 | —10 | 30 | 108 | 110 | 423 | 21 | 58 | —17 | 30 | 80 | 84 |
| 397 | 21 | 50 | —11 | 30 | 114 | 116 | 424 | 21 | 58 | —18 | 30 | 103 | 108 |
| 398 | 21 | 50 | —12 | 30 | 95 | 97 | 425 | 21 | 58 | —19 | 30 | 97 | 103 |
| 399 | 21 | 50 | —13 | 30 | 93 | 95 | 426 | 22 | 2 | — 5 | 30 | 86 | 86 |
| 400 | 21 | 50 | —14 | 30 | 83 | 85 | 427 | 22 | 2 | — 6 | 30 | 81 | 81 |
| 401 | 21 | 50 | —15 | 30 | 90 | 94 | 428 | 22 | 2 | — 7 | 30 | 52 | 52 |

TABLE II — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | | Dec. 1860. | | No. Stars. | No. Stars, Sec. δ | No. | R. A. 1860. | | Dec. 1860. | | No. Stars. | No. Stars, Sec. δ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h. | m. | ° | ′ | | | | h. | m. | ° | ′ | | |
| 429 | 22 | 2 | —8 | 30 | 81 | 82 | 456 | 22 | 26 | —5 | 30 | 84 | 84 |
| 430 | 22 | 2 | —9 | 30 | 86 | 87 | 457 | 22 | 26 | —6 | 30 | 92 | 92 |
| 431 | 22 | 6 | —5 | 30 | 96 | 96 | 458 | 22 | 26 | —7 | 30 | 105 | 106 |
| 432 | 22 | 6 | —6 | 30 | 99 | 100 | 459 | 22 | 26 | —8 | 30 | 90 | 91 |
| 433 | 22 | 6 | —7 | 30 | 80 | 81 | 460 | 22 | 26 | —9 | 30 | 106 | 107 |
| 434 | 22 | 6 | —8 | 30 | 93 | 94 | 461 | 22 | 30 | —5 | 30 | 79 | 79 |
| 435 | 22 | 6 | —9 | 30 | 90 | 91 | 462 | 22 | 30 | —6 | 30 | 105 | 106 |
| 436 | 22 | 10 | —5 | 30 | 67 | 67 | 463 | 22 | 30 | —7 | 30 | 83 | 84 |
| 437 | 22 | 10 | —6 | 30 | 86 | 86 | 464 | 22 | 30 | —8 | 30 | 102 | 103 |
| 438 | 22 | 10 | —7 | 30 | 77 | 78 | 465 | 22 | 30 | —9 | 30 | 74 | 75 |
| 439 | 22 | 10 | —8 | 30 | 76 | 77 | 466 | 22 | 34 | —5 | 30 | 111 | 111 |
| 440 | 22 | 10 | —9 | 30 | 84 | 85 | 467 | 22 | 34 | —6 | 30 | 93 | 94 |
| 441 | 22 | 14 | —5 | 30 | 68 | 68 | 468 | 22 | 34 | —7 | 30 | 82 | 83 |
| 442 | 22 | 14 | —6 | 30 | 74 | 74 | 469 | 22 | 34 | —8 | 30 | 97 | 98 |
| 443 | 22 | 14 | —7 | 30 | 74 | 75 | 470 | 22 | 34 | —9 | 30 | 101 | 102 |
| 444 | 22 | 14 | —8 | 30 | 79 | 80 | 471 | 22 | 38 | —5 | 30 | 86 | 86 |
| 445 | 22 | 14 | —9 | 30 | 90 | 91 | 472 | 22 | 38 | —6 | 30 | 89 | 89 |
| 446 | 22 | 18 | —5 | 30 | 94 | 94 | 473 | 22 | 38 | —7 | 30 | 118 | 119 |
| 447 | 22 | 18 | —6 | 30 | 82 | 82 | 474 | 22 | 38 | —8 | 30 | 103 | 104 |
| 448 | 22 | 18 | —7 | 30 | 93 | 94 | 475 | 22 | 38 | —9 | 30 | 108 | 109 |
| 449 | 22 | 18 | —8 | 30 | 87 | 88 | 476 | 22 | 42 | —5 | 30 | 113 | 113 |
| 450 | 22 | 18 | —9 | 30 | 86 | 87 | 477 | 22 | 42 | —6 | 30 | 111 | 111 |
| 451 | 22 | 22 | —5 | 30 | 108 | 108 | 478 | 22 | 42 | —7 | 30 | 96 | 97 |
| 452 | 22 | 22 | —6 | 30 | 91 | 91 | 479 | 22 | 42 | —8 | 30 | 89 | 90 |
| 453 | 22 | 22 | —7 | 30 | 76 | 77 | 480 | 22 | 42 | —9 | 30 | 114 | 115 |
| 454 | 22 | 22 | —8 | 30 | 105 | 106 | 481 | 22 | 46 | —5 | 30 | 115 | 115 |
| 455 | 22 | 22 | —9 | 30 | 95 | 96 | 482 | 22 | 46 | —6 | 30 | 90 | 91 |

TABLE II — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | No. Stars. | No Stars Sec. δ | No. | R. A. 1860. | Dec. 1860. | No. Stars. | No. Stars Sec. δ |
|---|---|---|---|---|---|---|---|---|---|
| | h. m. | ° ′ | | | | h. m. | ° ′ | | |
| 483 | 22 46 | — 7 30 | 87 | 88 | 492 | 22 54 | — 6 30 | 93 | 94 |
| 484 | 22 46 | — 8 30 | 82 | 83 | 493 | 22 54 | — 7 30 | 95 | 96 |
| 485 | 22 46 | — 9 30 | 91 | 92 | 494 | 22 54 | — 8 30 | 96 | 97 |
| 486 | 22 50 | — 5 30 | 83 | 83 | 495 | 22 54 | — 9 30 | 97 | 98 |
| 487 | 22 50 | — 6 30 | 82 | 82 | 496 | 22 58 | — 5 30 | 80 | 80 |
| 488 | 22 50 | — 7 30 | 113 | 114 | 497 | 22 58 | — 6 30 | 78 | 78 |
| 489 | 22 50 | — 8 30 | 96 | 97 | 498 | 22 58 | — 7 30 | 82 | 83 |
| 490 | 22 50 | — 9 30 | 93 | 94 | 499 | 22 58 | — 8 30 | 86 | 87 |
| 491 | 22 54 | — 5 30 | 74 | 74 | 500 | 22 58 | — 9 30 | 85 | 86 |

TABLE III – COUNTS OF STARS FROM THE ECLIPTIC CHARTS OF DR. J. PALISA.

(I = 6 inch telescope; II = 12 inch telescope.)

| No. | R. A. 1860. | Dec. 1860. | Telescope. | No. Stars. | 4 Sec. $\delta$ × No. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 1 | 0 1 0 | + 8 45 | I | 16 | 65 |
| 2 | 0 1 0 | + 8 15 | I | 27 | 109 |
| 3 | 0 1 0 | + 7 45 | I | 19 | 77 |
| 4 | 0 3 0 | + 8 45 | I | 27 | 109 |
| 5 | 0 3 0 | + 8 15 | I | 30 | 121 |
| 6 | 0 3 0 | —11 30 | II | 36 | 147 |
| 7 | 0 3 0 | —15 45 | II | 20 | 187 |
| 8 | 0 4 0 | — 8 15 | I | 15 | 61 |
| 9 | 0 5 0 | + 8 30 | I | 24 | 97 |
| 10 | 0 5 0 | —11 15 | II | 20 | 82 |
| 11 | 0 5 0 | —15 30 | II | 15 | 62 |
| 12 | 0 6 0 | — 8 15 | I | 25 | 101 |
| 13 | 0 6 0 | —10 45 | II | 25 | 102 |
| 14 | 0 7 0 | —15 15 | II | 20 | 83 |
| 15 | 0 8 0 | — 7 0 | I | 15 | 61 |
| 16 | 0 8 0 | — 7 45 | I | 20 | 81 |
| 17 | 0 8 0 | — 8 15 | I | 30 | 121 |
| 18 | 0 9 0 | + 9 15 | I | 21 | 85 |
| 19 | 0 9 0 | —14 45 | II | 27 | 111 |
| 20 | 0 10 0 | — 7 0 | I | 14 | 57 |
| 21 | 0 11 0 | — 8 0 | I | 17 | 69 |
| 22 | 0 13 0 | — 7 30 | I | 18 | 73 |
| 23 | 0 13 | —14 15 | II | 23 | 95 |
| 24 | 0 14 0 | + 9 15 | I | 11 | 44 |
| 25 | 0 14 0 | + 8 45 | I | 21 | 85 |

TABLE III — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | Telescope. | No. Stars. | 4 Sec. δ × No. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 26 | 0 14 0 | + 8 15 | I | 12 | 48 |
| 27 | 0 14 0 | + 7 45 | I | 9 | 36 |
| 28 | 0 14 0 | — 6 45 | I | 20 | 81 |
| 29 | 0 14 0 | —12 45 | II | 23 | 94 |
| 30 | 0 15 0 | + 7 15 | I | 20 | 81 |
| 31 | 0 15 0 | — 7 15 | I | 17 | 69 |
| 32 | 0 15 0 | —14 0 | II | 26 | 105 |
| 33 | 0 16 0 | + 9 15 | I | 23 | 93 |
| 34 | 0 16 0 | + 8 45 | I | 26 | 105 |
| 35 | 0 16 0 | + 8 15 | I | 13 | 53 |
| 36 | 0 16 0 | + 7 45 | I | 12 | 48 |
| 37 | 0 17 0 | —13 30 | II | 15 | 61 |
| 38 | 0 18 0 | + 8 30 | I | 16 | 65 |
| 39 | 0 18 0 | + 8 0 | I | 19 | 77 |
| 40 | 0 18 0 | + 7 30 | I | 8 | 32 |
| 41 | 0 19 0 | —12 45 | II | 28 | 114 |
| 42 | 0 19 0 | —13 15 | II | 29 | 119 |
| 43 | 0 20 0 | + 8 30 | I | 15 | 61 |
| 44 | 1 32 0 | + 6 15 | I & II | 17 | 69 |
| 45 | 1 33 0 | + 4 45 | I & II | 32 | 129 |
| 46 | 1 34 0 | + 6 15 | I & II | 23 | 93 |
| 47 | 1 34 0 | + 5 45 | I & II | 18 | 73 |
| 48 | 1 35 0 | + 5 15 | I & II | 29 | 117 |
| 49 | 1 36 0 | + 6 15 | I & II | 19 | 77 |
| 50 | 1 36 0 | + 5 45 | I & II | 22 | 89 |
| 51 | 1 37 0 | + 5 15 | I & II | 26 | 105 |
| 52 | 1 38 0 | + 6 15 | I & II | 18 | 73 |
| 53 | 1 38 0 | + 5 45 | I & II | 26 | 105 |

TABLE III — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | Telescope. | No. Stars. | 4 Sec. δ. × No. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 54 | 1 40 0 | +6 45 | I & II | 21 | 85 |
| 55 | 1 40 0 | +6 15 | I & II | 17 | 69 |
| 56 | 1 40 0 | +5 45 | I & II | 17 | 68 |
| 57 | 1 42 0 | +6 45 | I & II | 29 | 117 |
| 58 | 1 42 0 | +6 15 | I & II | 39 | 157 |
| 59 | 1 42 0 | +5 45 | I & II | 22 | 89 |
| 60 | 1 43 0 | +8 15 | I & II | 17 | 69 |
| 61 | 1 44 0 | +6 45 | I & II | 25 | 101 |
| 62 | 1 44 0 | +6 15 | I & II | 24 | 97 |
| 63 | 1 44 0 | +5 45 | I & II | 25 | 101 |
| 64 | 1 45 0 | +8 15 | I & II | 18 | 73 |
| 65 | 1 45 0 | +7 15 | I & II | 27 | 109 |
| 66 | 1 46 0 | +6 45 | I & II | 25 | 101 |
| 67 | 1 46 0 | +6 15 | I & II | 14 | 56 |
| 68 | 1 47 0 | +8 15 | I & II | 15 | 64 |
| 69 | 1 47 0 | +7 15 | I & II | 23 | 93 |
| 70 | 1 48 0 | +6 45 | I & II | 20 | 81 |
| 71 | 1 48 0 | +6 15 | I & II | 22 | 89 |
| 72 | 1 49 0 | +7 15 | I & II | 27 | 109 |
| 73 | 1 50 0 | +6 45 | I & II | 12 | 48 |
| 74 | 1 51 0 | +7 45 | I & II | 28 | 113 |
| 75 | 1 51 0 | +7 15 | I & II | 15 | 60 |
| 76 | 1 52 0 | +6 45 | I & II | 31 | 125 |
| 77 | 1 52 0 | −1 0 | I | 21 | 84 |
| 78 | 1 53 0 | +8 15 | I & II | 23 | 92 |
| 79 | 1 53 0 | +7 45 | I & II | 21 | 85 |
| 80 | 1 53 0 | +7 15 | I & II | 15 | 61 |
| 81 | 1 53 0 | 0 0 | I | 15 | 60 |

TABLE III—COUNTS OF STARS.—Continued.

| No. | R. A. 1860. | | | Dec. 1860. | | Telescope. | No. Stars. | 4 Sec. $\delta$ × No. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | ° | ′ | | | |
| 82 | 1 | 54 | 0 | — 0 | 30 | I | 19 | 76 |
| 83 | 1 | 54 | 0 | — 1 | 0 | I | 17 | 68 |
| 84 | 1 | 55 | 0 | + 8 | 45 | I & II | 34 | 137 |
| 85 | 1 | 55 | 0 | + 8 | 15 | I & II | 21 | 85 |
| 86 | 1 | 55 | 0 | + 7 | 45 | I & II | 13 | 52 |
| 87 | 1 | 55 | 0 | + 7 | 15 | I & II | 22 | 89 |
| 88 | 1 | 55 | 0 | — 0 | 0 | I | 19 | 76 |
| 89 | 1 | 56 | 0 | — 1 | 15 | I | 25 | 100 |
| 90 | 1 | 57 | 0 | + 8 | 45 | I & II | 23 | 93 |
| 91 | 1 | 57 | 0 | + 7 | 45 | I & II | 19 | 77 |
| 92 | 1 | 57 | 0 | + 7 | 15 | I & II | 14 | 56 |
| 93 | 1 | 57 | 0 | — 1 | 45 | I | 26 | 104 |
| 94 | 1 | 58 | 0 | — 1 | 15 | I | 23 | 92 |
| 95 | 1 | 59 | 0 | + 8 | 45 | I & II | 21 | 85 |
| 96 | 1 | 59 | 0 | + 7 | 45 | I & II | 24 | 97 |
| 97 | 1 | 59 | 0 | + 7 | 15 | I & II | 20 | 81 |
| 98 | 1 | 59 | 0 | — 1 | 45 | I | 17 | 68 |
| 99 | 2 | 3 | 0 | + 9 | 45 | II | 22 | 89 |
| 100 | 2 | 3 | 0 | + 7 | 45 | I | 21 | 85 |
| 101 | 2 | 3 | 0 | + 7 | 15 | I | 21 | 85 |
| 102 | 2 | 5 | 0 | +10 | 0 | II | 27 | 100 |
| 103 | 2 | 5 | 0 | + 7 | 45 | I | 18 | 73 |
| 104 | 2 | 5 | 0 | + 7 | 15 | I | 14 | 56 |
| 105 | 2 | 7 | 0 | +10 | 0 | II | 20 | 81 |
| 106 | 2 | 7 | 0 | + 7 | 45 | I | 14 | 56 |
| 107 | 2 | 7 | 0 | + 7 | 15 | I | 10 | 40 |
| 108 | 2 | 9 | 0 | + 7 | 45 | I | 20 | 81 |
| 109 | 2 | 11 | 0 | + 8 | 15 | I | 16 | 65 |

TABLE III — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | Telescope. | No. Stars. | 4 Sec. δ × No. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 110 | 2 11 0 | + 7 45 | I | 25 | 101 |
| 111 | 2 13 0 | + 8 15 | I | 18 | 73 |
| 112 | 2 13 0 | + 7 45 | I | 18 | 73 |
| 113 | 2 15 0 | + 8 45 | I | 15 | 61 |
| 114 | 2 15 0 | + 8 15 | I | 15 | 61 |
| 115 | 2 17 0 | + 8 45 | I | 15 | 61 |
| 116 | 2 19 0 | + 8 45 | I | 12 | 48 |
| 117 | 2 21 0 | + 9 15 | I | 25 | 101 |
| 118 | 2 21 0 | + 8 45 | I | 21 | 85 |
| 119 | 2 21 0 | + 8 15 | I | 23 | 93 |
| 120 | 2 22 0 | + 6 30 | I | 24 | 97 |
| 121 | 2 23 0 | + 9 15 | I | 26 | 105 |
| 122 | 2 23 0 | + 8 45 | I | 18 | 73 |
| 123 | 2 23 0 | + 8 15 | I | 24 | 97 |
| 124 | 2 25 0 | +10 15 | I | 21 | 86 |
| 125 | 2 25 0 | + 9 45 | I | 26 | 105 |
| 126 | 2 25 0 | + 9 15 | I | 19 | 77 |
| 127 | 2 25 0 | + 8 45 | I | 20 | 81 |
| 128 | 2 26 0 | + 6 45 | I | 22 | 89 |
| 129 | 2 27 0 | +10 15 | I | 27 | 110 |
| 130 | 2 27 0 | + 9 45 | I | 13 | 53 |
| 131 | 2 27 0 | + 9 15 | I | 24 | 97 |
| 132 | 2 27 0 | + 8 45 | I | 19 | 77 |
| 133 | 2 28 0 | + 6 45 | I | 22 | 89 |
| 134 | 2 29 0 | +10 15 | I | 22 | 90 |
| 135 | 2 29 0 | + 9 45 | I | 25 | 101 |
| 136 | 2 29 0 | + 9 15 | I | 21 | 85 |
| 137 | 2 29 0 | + 8 45 | I | 10 | 40 |

TABLE III—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | Telescope. | No. Stars. | 4 Sec. $\delta$ × No. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 138 | 2 31 0 | +21 45 | I | 23 | 99 |
| 139 | 2 31 0 | +21 15 | I | 26 | 111 |
| 140 | 2 31 0 | +20 45 | I | 27 | 114 |
| 141 | 2 31 0 | +10 15 | I | 21 | 86 |
| 142 | 2 31 0 | + 9 45 | I | 22 | 89 |
| 143 | 2 31 0 | + 9 15 | I | 21 | 85 |
| 144 | 2 31 0 | + 8 45 | I | 21 | 85 |
| 145 | 2 33 0 | +21 45 | I | 18 | 78 |
| 146 | 2 33 0 | +21 15 | I | 20 | 86 |
| 147 | 2 33 0 | +20 45 | I | 37 | 158 |
| 148 | 2 33 0 | +10 45 | I | 19 | 78 |
| 149 | 2 33 0 | +10 15 | I | 13 | 53 |
| 150 | 2 33 0 | + 9 45 | I | 23 | 93 |
| 151 | 2 33 0 | + 9 15 | I | 18 | 73 |
| 152 | 2 33 0 | + 8 45 | I | 15 | 61 |
| 153 | 2 35 0 | +21 15 | I | 12 | 51 |
| 154 | 2 35 0 | +11 15 | I | 26 | 106 |
| 155 | 2 35 0 | +10 45 | I | 16 | 65 |
| 156 | 2 35 0 | +10 15 | I | 18 | 73 |
| 157 | 2 35 0 | + 9 45 | I | 23 | 93 |
| 158 | 2 35 0 | + 9 15 | I | 10 | 40 |
| 159 | 2 35 0 | + 8 45 | I | 18 | 73 |
| 160 | 2 37 0 | +11 15 | I | 22 | 90 |
| 161 | 2 37 0 | +10 45 | I | 27 | 110 |
| 162 | 2 37 0 | +10 15 | I | 15 | 61 |
| 163 | 2 37 0 | + 9 45 | I | 21 | 85 |
| 164 | 2 37 0 | + 9 15 | I | 17 | 69 |
| 165 | 2 37 0 | + 8 45 | I | 13 | |

TABLE III—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | | | Dec. 1860. | | Telescope. | No. Stars. | 4 Sec. δ × No. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | ° | ′ | | | |
| 166 | 2 | 39 | 0 | +11 | 15 | I | 25 | 102 |
| 167 | 2 | 39 | 0 | +10 | 45 | I | 20 | 82 |
| 168 | 2 | 39 | 0 | +10 | 15 | I | 19 | 77 |
| 169 | 2 | 39 | 0 | + 9 | 45 | I | 13 | 53 |
| 170 | 2 | 41 | 0 | +11 | 15 | I | 22 | 90 |
| 171 | 2 | 41 | 0 | +10 | 45 | I | 21 | 86 |
| 172 | 2 | 41 | 0 | +10 | 15 | I | 19 | 77 |
| 173 | 2 | 41 | 0 | + 9 | 45 | I | 25 | 101 |
| 174 | 2 | 43 | 0 | +19 | 45 | I | 31 | 131 |
| 175 | 2 | 43 | 0 | +11 | 15 | I | 20 | 82 |
| 176 | 2 | 43 | 0 | +10 | 45 | I | 19 | 77 |
| 177 | 2 | 43 | 0 | +10 | 15 | I | 22 | 90 |
| 178 | 2 | 43 | 0 | + 9 | 45 | I | 13 | 53 |
| 179 | 2 | 45 | 0 | +19 | 45 | I | 24 | 102 |
| 180 | 2 | 45 | 0 | +19 | 15 | I | 26 | 110 |
| 181 | 2 | 45 | 0 | +11 | 15 | I | 20 | 82 |
| 182 | 2 | 45 | 0 | +10 | 45 | I | 18 | 73 |
| 183 | 2 | 45 | 0 | +10 | 15 | I | 14 | 57 |
| 184 | 2 | 47 | 0 | +19 | 15 | I | 16 | 68 |
| 185 | 2 | 47 | 0 | +11 | 15 | I | 12 | 49 |
| 186 | 2 | 47 | 0 | +10 | 15 | I | 14 | 57 |
| 187 | 2 | 49 | 0 | +19 | 15 | I | 13 | 55 |
| 188 | 2 | 49 | 0 | +11 | 15 | I | 14 | 57 |
| 189 | 2 | 51 | 0 | +19 | 15 | I | 19 | 81 |
| 190 | 2 | 53 | 0 | +19 | 15 | I | 17 | 72 |
| 191 | 2 | 55 | 0 | +19 | 15 | I | 26 | 110 |
| 192 | 2 | 57 | 0 | +19 | 15 | I | 23 | 97 |
| 193 | 2 | 59 | 0 | +19 | 15 | I | 15 | 64 |

TABLE III — COUNTS OF STARS — Continued.

| No | R. A. 1860. | | | Dec. 1860. | | Telescope. | No. Stars | 4 Sec. $\delta$ ×No. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | ° | ′ | | | |
| 194 | 3 | 1 | 0 | +19 | 45 | II | 31 | 131 |
| 195 | 3 | 1 | 0 | +19 | 15 | II | 26 | 110 |
| 196 | 3 | 1 | 0 | +18 | 45 | II | 45 | 190 |
| 197 | 3 | 1 | 0 | +18 | 15 | II | 28 | 118 |
| 198 | 3 | 1 | 0 | +17 | 45 | II | 29 | 122 |
| 199 | 3 | 1 | 0 | +17 | 15 | II | 23 | 97 |
| 200 | 3 | 1 | 0 | +12 | 0 | I | 18 | 73 |
| 201 | 3 | 3 | 0 | +19 | 45 | II | 20 | 85 |
| 202 | 3 | 3 | 0 | +19 | 15 | II | 25 | 106 |
| 203 | 3 | 3 | 0 | +18 | 45 | II | 44 | 186 |
| 204 | 3 | 3 | 0 | +18 | 15 | II | 38 | 149 |
| 205 | 3 | 3 | 0 | +17 | 45 | II | 31 | 130 |
| 206 | 3 | 3 | 0 | +12 | 0 | I | 10 | 41 |
| 207 | 3 | 5 | 0 | +18 | 45 | II | 42 | 178 |
| 208 | 3 | 5 | 0 | +18 | 15 | II | 36 | 151 |
| 209 | 3 | 5 | 0 | +17 | 45 | II | 33 | 138 |
| 210 | 3 | 5 | 0 | +12 | 15 | I | 15 | 61 |
| 211 | 3 | 7 | 0 | +12 | 15 | I | 18 | 73 |
| 212 | 3 | 9 | 0 | +12 | 15 | I | 10 | 41 |
| 213 | 3 | 11 | 0 | +19 | 30 | II | 35 | 153 |
| 214 | 3 | 11 | 0 | +12 | 15 | I | 14 | 57 |
| 215 | 3 | 13 | 0 | +19 | 30 | II | 34 | 144 |
| 216 | 3 | 13 | 0 | +12 | 30 | I | 15 | 61 |
| 217 | 3 | 15 | 0 | +19 | 30 | II | 30 | 127 |
| 218 | 3 | 15 | 0 | +12 | 30 | I | 11 | 45 |
| 219 | 3 | 17 | 0 | +19 | 45 | II | 34 | 144 |
| 220 | 3 | 19 | 0 | +19 | 45 | II | 31 | 131 |
| 221 | 3 | 21 | 0 | +8 | 30 | I | 26 | 105 |

TABLE III — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | Telescope. | No. Stars. | 4 Sec. $\delta$ × No. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 222 | 3 22 0 | +20 0 | II | 17 | 72 |
| 223 | 3 23 0 | + 8 30 | I | 14 | 57 |
| 224 | 3 24 0 | +20 15 | II | 46 | 194 |
| 225 | 3 25 0 | + 8 30 | I | 11 | 45 |
| 226 | 3 26 0 | +20 15 | II | 38 | 161 |
| 227 | 3 26 0 | +18 0 | II | 32 | 134 |
| 228 | 3 27 0 | + 8 30 | I | 11 | 44 |
| 229 | 3 28 0 | +18 0 | II | 18 | 79 |
| 230 | 3 29 0 | + 8 30 | I | 12 | 48 |
| 231 | 3 31 0 | +19 30 | I | 21 | 89 |
| 232 | 3 32 0 | + 8 45 | I | 12 | 48 |
| 233 | 3 33 0 | +19 30 | I | 25 | 106 |
| 234 | 3 34 0 | +20 0 | I | 15 | 64 |
| 235 | 3 34 0 | + 8 45 | I | 16 | 65 |
| 236 | 3 35 0 | +19 30 | I | 28 | 119 |
| 237 | 3 36 0 | +20 0 | I | 23 | 97 |
| 238 | 3 36 0 | + 8 45 | I | 22 | 89 |
| 239 | 3 37 0 | +19 30 | I | 34 | 144 |
| 240 | 3 38 0 | +20 0 | I | 35 | 148 |
| 241 | 3 38 0 | + 8 45 | I | 24 | 97 |
| 242 | 3 39 0 | +19 30 | I | 26 | 110 |
| 243 | 3 40 0 | +20 0 | I | 20 | 85 |
| 244 | 3 40 0 | + 8 45 | I | 16 | 65 |
| 245 | 3 46 0 | +20 15 | I | 28 | 119 |
| 246 | 3 47 0 | +19 45 | I | 24 | 102 |
| 247 | 3 48 0 | +20 15 | I | 25 | 106 |
| 248 | 3 49 0 | +19 45 | I | 22 | 93 |
| 249 | 3 50 0 | +20 15 | I | 22 | 93 |

TABLE III—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860 | Telescope. | No. Stars. | 4 Sec. $\delta$ × No. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 250 | 3 51 0 | +20 45 | I | 45 | 191 |
| 251 | 3 51 0 | +19 45 | I | 27 | 114 |
| 252 | 3 52 0 | +20 15 | I | 23 | 97 |
| 253 | 3 53 0 | +20 45 | I | 25 | 106 |
| 254 | 3 55 0 | +20 45 | I | 34 | 145 |
| 255 | 3 57 0 | +21 0 | I | 31 | 132 |
| 256 | 3 59 0 | +21 0 | I | 30 | 128 |
| 257 | 4 2 0 | + 9 45 | I | 22 | 89 |
| 258 | 4 4 0 | +10 0 | I | 26 | 106 |
| 259 | 4 6 0 | +10 15 | I | 25 | 102 |
| 260 | 4 8 0 | +10 30 | I | 23 | 94 |
| 261 | 4 10 0 | +10 45 | I | 23 | 94 |
| 262 | 4 12 0 | +11 0 | I | 20 | 82 |
| 263 | 4 14 0 | +11 30 | I | 33 | 135 |
| 264 | 4 16 0 | +11 45 | I | 23 | 94 |
| 265 | 4 18 0 | +12 0 | I | 30 | 122 |
| 266 | 4 24 0 | +13 15 | I | 18 | 74 |
| 267 | 4 25 0 | +12 15 | I | 34 | 139 |
| 268 | 4 26 0 | +13 15 | I | 29 | 119 |
| 269 | 4 27 0 | +12 30 | I | 31 | 126 |
| 270 | 4 28 0 | +13 15 | I | 25 | 102 |
| 271 | 4 29 0 | +12 45 | I | 39 | 160 |
| 272 | 4 30 0 | +13 15 | I | 24 | 99 |
| 273 | 4 31 0 | +21 30 | I | 25 | 107 |
| 274 | 4 32 0 | +13 15 | I | 32 | 132 |
| 275 | 4 33 0 | +21 30 | I | 23 | 99 |
| 276 | 4 34 0 | +13 15 | I | 32 | 132 |
| 277 | 4 35 0 | +21 45 | I | 24 | 104 |

TABLE III.—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | Telescope. | No. Stars. | 4 Sec. $\delta$ × No. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 278 | 4 36 0 | +13 15 | I | 16 | 66 |
| 279 | 4 37 0 | +21 45 | I | 22 | 95 |
| 280 | 4 39 0 | +22 15 | I | 24 | 104 |
| 281 | 4 39 0 | +21 45 | I | 18 | 78 |
| 282 | 4 41 0 | +13 30 | I | 28 | 115 |
| 283 | 4 43 0 | +13 30 | I | 24 | 99 |
| 284 | 4 48 0 | +13 45 | I | 23 | 95 |
| 285 | 4 50 0 | +13 45 | I | 30 | 124 |
| 286 | 4 52 0 | +13 45 | I | 30 | 124 |
| 287 | 4 54 0 | +13 45 | I | 27 | 111 |
| 288 | 4 56 0 | +13 45 | I | 33 | 136 |
| 289 | 4 58 0 | +13 45 | I | 39 | 161 |
| 290 | 5 0 0 | +13 45 | I | 38 | 157 |
| 291 | 5 41 0 | +15 0 | I | 42 | 174 |
| 292 | 5 43 0 | +15 0 | I | 54 | 224 |
| 293 | 5 45 0 | +15 15 | I | 57 | 237 |
| 294 | 5 47 0 | +15 15 | I | 73 | 304 |
| 295 | 5 51 0 | +16 15 | I | 41 | 170 |
| 296 | 5 53 0 | +16 30 | I | 29 | 120 |
| 297 | 6 21 0 | +28 0 | I | 68 | 285 |
| 298 | 6 21 0 | +27 30 | I | 67 | 289 |
| 299 | 6 30 0 | +28 15 | I | 71 | 320 |
| 300 | 6 33 0 | +27 15 | I | 63 | 284 |
| 301 | 6 40 0 | +23 15 | I | 75 | 324 |
| 302 | 6 42 0 | +23 15 | I | 71 | 309 |
| 303 | 6 44 0 | +23 15 | I | 63 | 274 |
| 304 | 6 46 0 | +23 7.5 | I | 77 | 335 |
| 305 | 6 48 0 | +23 7.5 | I | 84 | 365 |
| 306 | 6 50 0 | +23 7.5 | I | 69 | 300 |

TABLE III.—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | | | Dec. 1860. | | Telescope. | No. Stars. | 4 Sec. δ × No. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | ° | ′ | | | |
| 307 | 6 | 52 | 0 | +23 | 0 | I | 97 | 423 |
| 308 | 6 | 54 | 0 | +23 | 0 | I | 92 | 401 |
| 309 | 7 | 22 | 0 | +22 | 30 | I | 32 | 138 |
| 310 | 7 | 24 | 0 | +22 | 30 | I | 42 | 181 |
| 311 | 7 | 26 | 0 | +22 | 30 | I | 41 | 177 |
| 312 | 7 | 28 | 0 | +22 | 30 | I | 38 | 164 |
| 313 | 7 | 30 | 0 | +22 | 30 | I | 55 | 238 |
| 314 | 7 | 32 | 0 | +22 | 30 | I | 49 | 212 |
| 315 | 7 | 41 | 0 | +29 | 0 | II | 43 | 196 |
| 316 | 7 | 43 | 0 | +29 | 0 | II | 44 | 201 |
| 317 | 7 | 44 | 0 | +26 | 30 | I | 44 | 197 |
| 318 | 7 | 44 | 0 | +26 | 0 | I | 36 | 149 |
| 319 | 7 | 44 | 0 | +19 | 30 | I | 44 | 186 |
| 320 | 7 | 45 | 0 | +29 | 0 | II | 53 | 241 |
| 321 | 7 | 46 | 0 | +26 | 30 | I | 42 | 188 |
| 322 | 7 | 46 | 0 | +26 | 0 | I | 30 | 133 |
| 323 | 7 | 46 | 0 | +19 | 30 | I | 39 | 165 |
| 324 | 7 | 47 | 0 | +29 | 0 | II | 49 | 224 |
| 325 | 7 | 48 | 0 | +26 | 30 | I | 52 | 233 |
| 326 | 7 | 48 | 0 | +19 | 15 | I | 47 | 199 |
| 327 | 7 | 49 | 0 | +29 | 0 | II | 34 | 155 |
| 328 | 7 | 50 | 0 | +26 | 30 | I | 35 | 157 |
| 329 | 7 | 50 | 0 | +19 | 15 | I | 53 | 225 |
| 330 | 7 | 51 | 0 | +29 | 0 | II | 37 | 170 |
| 331 | 7 | 52 | 0 | +26 | 30 | I | 37 | 166 |
| 332 | 7 | 53 | 0 | +29 | 0 | II | 36 | 164 |
| 333 | 7 | 54 | 0 | +26 | 30 | I | 31 | 141 |
| 334 | 7 | 54 | 0 | + 8 | 30 | I | 52 | 210 |

TABLE III—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | | | Dec. 1860. | | Telescope. | No. Stars | 4 Sec. $\delta$ × No. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | ° | ′ | | | |
| 335 | 7 | 55 | 0 | +29 | 0 | II | 40 | 182 |
| 336 | 7 | 56 | 0 | + 8 | 30 | I | 39 | 158 |
| 337 | 7 | 57 | 0 | +29 | 0 | II | 40 | 182 |
| 338 | 7 | 58 | 0 | +19 | 15 | I | 40 | 170 |
| 339 | 7 | 58 | 0 | + 8 | 30 | I | 45 | 342 |
| 340 | 7 | 59 | 0 | +29 | 0 | II | 34 | 155 |
| 341 | 7 | 59 | 0 | +19 | 45 | I | 23 | 99 |
| 342 | 8 | 0 | 0 | +19 | 15 | I | 27 | 114 |
| 343 | 8 | 1 | 0 | +29 | 30 | II | 49 | 225 |
| 344 | 8 | 1 | 0 | +22 | 15 | II | 59 | 154 |
| 345 | 8 | 1 | 0 | +21 | 45 | II | 44 | 190 |
| 346 | 8 | 1 | 0 | +21 | 15 | II | 53 | 229 |
| 347 | 8 | 1 | 0 | +20 | 45 | II | 50 | 214 |
| 348 | 8 | 1 | 0 | +20 | 15 | II | 46 | 197 |
| 349 | 8 | 1 | 0 | +19 | 45 | II | 56 | 237 |
| 350 | 8 | 1 | 0 | +19 | 15 | II | 59 | 250 |
| 351 | 8 | 1 | 0 | +18 | 45 | II | 62 | 262 |
| 352 | 8 | 1 | 0 | +18 | 15 | II | 47 | 199 |
| 353 | 8 | 1 | 0 | +17 | 45 | II | 58 | 243 |
| 354 | 8 | 3 | 0 | +22 | 15 | II | 58 | 250 |
| 355 | 8 | 3 | 0 | +21 | 45 | II | 55 | 238 |
| 356 | 8 | 3 | 0 | +21 | 15 | II | 52 | 224 |
| 357 | 8 | 3 | 0 | +20 | 45 | II | 66 | 282 |
| 358 | 8 | 3 | 0 | +20 | 15 | II | 54 | 231 |
| 359 | 8 | 3 | 0 | +19 | 45 | II | 61 | 259 |
| 360 | 8 | 3 | 0 | +18 | 15 | II | 56 | 235 |
| 361 | 8 | 3 | 0 | +17 | 45 | II | 47 | 197 |
| 362 | 8 | 5 | 0 | +22 | 15 | II | 48 | 207 |

TABLE III.—COUNTS OF STARS—Continued.

| No | R. A. 1860. | | | Dec. 1860. | | Telescope. | No. Stars. | 4 Sec. $\delta$ × No. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | ° | ′ | | | |
| 363 | 8 | 5 | 0 | +21 | 45 | II | 53 | 229 |
| 364 | 8 | 5 | 0 | +21 | 15 | II | 49 | 209 |
| 365 | 8 | 5 | 0 | +20 | 45 | II | 53 | 227 |
| 366 | 8 | 5 | 0 | +20 | 15 | II | 41 | 174 |
| 367 | 8 | 5 | 0 | +19 | 45 | II | 59 | 250 |
| 368 | 8 | 6 | 0 | + 9 | 15 | I | 50 | 202 |
| 369 | 8 | 10 | 0 | + 1 | 0 | I | 51 | 204 |
| 370 | 8 | 12 | 0 | + 1 | 0 | I | 47 | 188 |
| 371 | 8 | 14 | 0 | + 9 | 0 | I | 43 | 174 |
| 372 | 8 | 14 | 0 | + 0 | 45 | I | 61 | 244 |
| 373 | 8 | 16 | 0 | + 9 | 0 | I | 39 | 158 |
| 374 | 8 | 16 | 0 | + 0 | 30 | I | 43 | 172 |
| 375 | 8 | 42 | 0 | + 7 | 15 | I | 26 | 105 |
| 376 | 8 | 44 | 0 | + 7 | 15 | I | 27 | 109 |
| 377 | 9 | 14 | 0 | +23 | 15 | I | 19 | 82 |
| 378 | 9 | 15 | 0 | +24 | 15 | I | 10 | 44 |
| 379 | 9 | 15 | 0 | +23 | 45 | I | 14 | 61 |
| 380 | 9 | 16 | 0 | +24 | 45 | I | 16 | 70 |
| 381 | 9 | 16 | 0 | +23 | 15 | I | 18 | 73 |
| 382 | 9 | 17 | 0 | +24 | 15 | I | 17 | 77 |
| 383 | 9 | 17 | 0 | +23 | 45 | I | 10 | 44 |
| 384 | 9 | 17 | 0 | +22 | 45 | I | 17 | 73 |
| 385 | 9 | 17 | 0 | +21 | 45 | I | 24 | 104 |
| 386 | 9 | 18 | 0 | +24 | 45 | I | 11 | 48 |
| 387 | 9 | 18 | 0 | +23 | 15 | I | 21 | 91 |
| 388 | 9 | 19 | 0 | +24 | 15 | I | 17 | 75 |
| 389 | 9 | 19 | 0 | +23 | 45 | I | 14 | 61 |
| 390 | 9 | 19 | 0 | +22 | 45 | I | 18 | 78 |

TABLE III — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | | | Dec. 1860. | | Telescope. | No. Stars. | 4 Sec. δ × No. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | ° | ′ | | | |
| 391 | 9 | 19 | 0 | +22 | 15 | I | 20 | 86 |
| 392 | 9 | 19 | 0 | +21 | 45 | I | 14 | 60 |
| 393 | 9 | 20 | 0 | +24 | 45 | I | 10 | 44 |
| 394 | 9 | 20 | 0 | +23 | 15 | I | 11 | 48 |
| 395 | 9 | 21 | 0 | +24 | 15 | I | 15 | 66 |
| 396 | 9 | 21 | 0 | +23 | 45 | I | 26 | 113 |
| 397 | 9 | 21 | 0 | +22 | 45 | I | 16 | 69 |
| 398 | 9 | 21 | 0 | +22 | 15 | I | 10 | 43 |
| 399 | 9 | 21 | 9 | +21 | 45 | I | 13 | 56 |
| 400 | 9 | 21 | 0 | +21 | 15 | I | 20 | 86 |
| 401 | 9 | 21 | 0 | + 6 | 45 | I | 29 | 117 |
| 402 | 9 | 22 | 0 | +24 | 45 | I | 19 | 84 |
| 403 | 9 | 22 | 0 | +23 | 15 | I | 9 | 39 |
| 404 | 9 | 23 | 0 | +24 | 15 | I | 27 | 118 |
| 405 | 9 | 23 | 0 | +23 | 45 | I | 13 | 57 |
| 406 | 9 | 23 | 0 | +22 | 45 | I | 16 | 69 |
| 407 | 9 | 23 | 0 | +22 | 15 | I | 19 | 82 |
| 408 | 9 | 23 | 0 | +21 | 45 | I | 11 | 47 |
| 409 | 9 | 23 | 0 | +21 | 15 | I | 18 | 77 |
| 410 | 9 | 23 | 0 | + 6 | 45 | I | 31 | 78 |
| 411 | 9 | 24 | 0 | +23 | 15 | I | 17 | 74 |
| 412 | 9 | 25 | 0 | +24 | 15 | I | 12 | 53 |
| 413 | 9 | 25 | 0 | +23 | 45 | I | 17 | 74 |
| 414 | 9 | 25 | 0 | +22 | 45 | I | 14 | 60 |
| 415 | 9 | 25 | 0 | +22 | 15 | I | 15 | 65 |
| 416 | 9 | 25 | 0 | +21 | 15 | I | 12 | 51 |
| 417 | 9 | 25 | 0 | + 6 | 45 | I | 34 | 137 |
| 418 | 9 | 26 | 0 | +24 | 45 | I | 21 | 92 |

TABLE III. — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | | | Dec. 1860. | | Telescope. | No. Stars. | 4 Sec. $\delta$. × No. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | ° | ′ | | | |
| 419 | 9 | 26 | 0 | +23 | 15 | I | 11 | 48 |
| 420 | 9 | 27 | 0 | +24 | 15 | I | 16 | 70 |
| 421 | 9 | 27 | 0 | +23 | 45 | I | 18 | 85 |
| 422 | 9 | 27 | 0 | +22 | 45 | I | 16 | 69 |
| 423 | 9 | 27 | 0 | +22 | 15 | I | 14 | 60 |
| 424 | 9 | 27 | 0 | + 6 | 30 | I | 26 | 105 |
| 425 | 9 | 28 | 0 | +24 | 45 | I | 22 | 96 |
| 426 | 9 | 28 | 0 | +23 | 15 | I | 24 | 106 |
| 427 | 9 | 29 | 0 | +24 | 15 | I | 14 | 62 |
| 428 | 9 | 29 | 0 | +23 | 45 | I | 27 | 118 |
| 429 | 9 | 29 | 0 | +22 | 45 | I | 20 | 86 |
| 430 | 9 | 30 | 0 | +24 | 45 | I | 11 | 48 |
| 431 | 9 | 30 | 0 | +23 | 15 | I | 14 | 61 |
| 432 | 9 | 31 | 0 | +24 | 15 | I | 19 | 84 |
| 433 | 9 | 31 | 0 | +23 | 45 | I | 22 | 96 |
| 434 | 9 | 31 | 0 | +22 | 45 | I | 11 | 48 |
| 435 | 9 | 31 | 0 | +22 | 15 | II | 13 | 56 |
| 436 | 9 | 31 | 0 | +11 | 30 | I | 26 | 106 |
| 437 | 9 | 32 | 0 | +23 | 15 | I | 19 | 83 |
| 438 | 9 | 32 | 0 | +11 | 0 | I | 28 | 114 |
| 439 | 9 | 33 | 0 | +24 | 15 | I | 17 | 75 |
| 440 | 9 | 33 | 0 | +23 | 45 | I | 20 | 87 |
| 441 | 9 | 33 | 0 | +22 | 45 | II | 17 | 73 |
| 442 | 9 | 33 | 0 | +22 | 15 | II | 21 | 91 |
| 443 | 9 | 33 | 0 | +21 | 45 | II | 14 | 60 |
| 444 | 9 | 33 | 0 | +11 | 30 | I | 21 | 86 |
| 445 | 9 | 33 | 0 | +10 | 30 | I | 23 | 94 |
| 446 | 9 | 33 | 0 | +10 | 0 | I | 33 | 135 |

TABLE III — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | Telescope. | No. Stars. | 4 Sec. δ × No. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 447 | 9 34 0 | +23 15 | I | 10 | 44 |
| 448 | 9 34 0 | +21 15 | II | 20 | 83 |
| 449 | 9 34 0 | +11 0 | I | 25 | 102 |
| 450 | 9 35 0 | +24 15 | I | 12 | 53 |
| 451 | 9 35 0 | +22 45 | II | 17 | 73 |
| 452 | 9 35 0 | +22 15 | II | 24 | 104 |
| 453 | 9 35 0 | +21 45 | II | 12 | 52 |
| 454 | 9 35 0 | + 6 15 | I | 32 | 129 |
| 455 | 9 36 0 | +21 15 | II | 16 | 58 |
| 456 | 9 37 0 | +24 15 | I | 20 | 88 |
| 457 | 9 37 0 | +22 45 | II | 22 | 97 |
| 458 | 9 37 0 | +22 15 | II | 18 | 78 |
| 459 | 9 37 0 | +21 45 | II | 19 | 81 |
| 460 | 9 37 0 | + 6 15 | I | 35 | 141 |
| 461 | 9 38 0 | +23 45 | II | 15 | 66 |
| 462 | 9 38 0 | +23 15 | II | 20 | 87 |
| 463 | 9 38 0 | +21 15 | II | 19 | 63 |
| 464 | 9 39 0 | +24 15 | II | 22 | 96 |
| 465 | 9 39 0 | +22 45 | II | 22 | 95 |
| 466 | 9 39 0 | +22 15 | II | 25 | 108 |
| 467 | 9 39 0 | +21 45 | II | 24 | 103 |
| 468 | 9 39 0 | + 6 15 | I | 23 | 93 |
| 469 | 9 40 0 | +23 45 | II | 20 | 87 |
| 470 | 9 40 0 | +23 15 | II | 24 | 106 |
| 471 | 9 40 0 | +21 15 | II | 24 | 103 |
| 472 | 9 41 0 | + 6 15 | I | 28 | 113 |
| 473 | 9 43 0 | + 6 15 | I | 30 | 121 |
| 474 | 9 45 0 | + 7 0 | I | 25 | 101 |

TABLE III—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | Telescope. | No. Stars. | 4 Sec. $\delta$ × No. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 475 | 9 45 0 | + 6 15 | I | 26 | 105 |
| 476 | 9 47 0 | + 7 0 | I | 22 | 89 |
| 477 | 9 49 0 | + 7 0 | I | 27 | 109 |
| 478 | 9 50 0 | + 5 45 | I | 23 | 93 |
| 479 | 9 52 0 | + 5 45 | I | 34 | 137 |
| 480 | 9 54 0 | + 5 45 | I | 25 | 101 |
| 481 | 10 8 0 | + 8 45 | I | 22 | 89 |
| 482 | 10 8 0 | + 8 15 | I | 14 | 57 |
| 483 | 10 8 0 | + 7 45 | I | 18 | 73 |
| 484 | 10 9 0 | + 6 45 | I | 17 | 69 |
| 485 | 10 10 0 | + 8 45 | I | 21 | 84 |
| 486 | 10 10 0 | + 8 15 | I | 24 | 97 |
| 487 | 10 10 0 | + 7 45 | I | 10 | 40 |
| 488 | 10 10 0 | + 7 15 | I | 20 | 81 |
| 489 | 10 11 0 | + 6 45 | I | 21 | 85 |
| 490 | 10 12 0 | + 8 45 | I | 15 | 61 |
| 491 | 10 12 0 | + 8 15 | I | 28 | 113 |
| 492 | 10 12 0 | + 7 45 | I | 32 | 125 |
| 493 | 10 12 0 | + 7 15 | I | 21 | 85 |
| 494 | 10 13 0 | + 6 45 | I | 18 | 73 |
| 495 | 10 14 0 | + 8 15 | I | 20 | 81 |
| 496 | 10 14 0 | + 7 45 | I | 18 | 73 |
| 497 | 10 14 0 | + 7 15 | I | 34 | 137 |
| 498 | 10 14 0 | + 6 15 | I | 27 | 109 |
| 499 | 10 15 0 | + 6 45 | I | 32 | 129 |
| 500 | 10 16 0 | + 7 45 | I | 33 | 133 |
| 501 | 10 16 0 | + 7 15 | I | 24 | 97 |
| 502 | 10 16 0 | + 6 15 | I | 29 | 117 |

TABLE III—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860 | Telescope. | No. Stars. | 4 Sec. $\delta$ × No. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 503 | 10 17 0 | + 6 45 | I | 17 | 69 |
| 504 | 10 18 0 | + 7 45 | I | 28 | 113 |
| 505 | 10 18 0 | + 7 15 | I | 21 | 85 |
| 506 | 10 20 0 | + 7 45 | I | 23 | 93 |
| 507 | 10 20 0 | + 7 15 | I | 25 | 101 |
| 508 | 10 28 0 | + 6 30 | I | 16 | 65 |
| 509 | 10 30 0 | + 6 30 | I | 24 | 97 |
| 510 | 10 34 0 | + 5 45 | I | 16 | 64 |
| 511 | 10 36 0 | + 5 45 | I | 21 | 84 |
| 512 | 10 38 0 | + 5 30 | I | 18 | 72 |
| 513 | 10 40 0 | + 5 30 | I | 11 | 44 |
| 514 | 11 1 0 | + 9 45 | I | 22 | 89 |
| 515 | 11 1 0 | — 3 30 | I | 16 | 64 |
| 516 | 11 2 0 | +15 15 | I | 16 | 66 |
| 517 | 11 4 0 | + 9 30 | II | 23 | 94 |
| 518 | 11 3 0 | — 3 30 | I | 23 | 92 |
| 519 | 11 4 0 | +15 0 | I | 14 | 58 |
| 520 | 11 5 0 | + 9 15 | II | 25 | 101 |
| 521 | 11 5 0 | + 8 45 | II | 17 | 69 |
| 522 | 11 5 0 | — 3 45 | I | 18 | 72 |
| 523 | 11 6 0 | +14 45 | I | 14 | 58 |
| 524 | 11 7 0 | + 8 45 | II | 35 | 141 |
| 525 | 11 7 0 | — 4 0 | I | 34 | 136 |
| 526 | 11 8 0 | +14 30 | I | 10 | 41 |
| 527 | 11 9 0 | + 8 30 | II | 23 | 93 |
| 528 | 11 9 0 | — 4 0 | I | 23 | 92 |
| 529 | 11 11 0 | — 4 15 | I | 21 | 84 |
| 530 | 11 13 0 | — 4 15 | I | 18 | 72 |

TABLE III.— COUNTS OF STARS — Continued.

| No | R. A. 1860. | | | Dec. 1860. | | Telescope. | No. Stars. | 4 Sec. $\delta$ × No. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | ° | ′ | | | |
| 531 | 11 | 15 | 0 | +13 | 15 | I | 18 | 74 |
| 532 | 11 | 15 | 0 | — 4 | 30 | I | 23 | 92 |
| 533 | 11 | 17 | 0 | +13 | 15 | I | 17 | 70 |
| 534 | 11 | 17 | 0 | — 4 | 30 | I | 23 | 92 |
| 535 | 11 | 17 | 0 | — 5 | 0 | I | 16 | 64 |
| 536 | 11 | 19 | 0 | +13 | 45 | I | 19 | 78 |
| 537 | 11 | 19 | 0 | +12 | 45 | I | 18 | 74 |
| 538 | 11 | 19 | 0 | — 4 | 30 | I | 21 | 84 |
| 529 | 11 | 19 | 0 | — 5 | 0 | I | 24 | 96 |
| 540 | 11 | 21 | 0 | +13 | 45 | I | 18 | 74 |
| 541 | 11 | 21 | 0 | +12 | 45 | I | 16 | 66 |
| 542 | 11 | 21 | 0 | — 4 | 45 | I | 14 | 56 |
| 543 | 11 | 25 | 0 | — 5 | 0 | I | 26 | 104 |
| 544 | 11 | 31 | 0 | — 5 | 30 | I | 13 | 52 |
| 545 | 11 | 33 | 0 | — 5 | 45 | I | 20 | 80 |
| 546 | 11 | 35 | 0 | — 5 | 45 | I | 25 | 100 |
| 547 | 11 | 37 | 0 | — 6 | 0 | I | 14 | 56 |
| 548 | 11 | 39 | 0 | — 6 | 0 | I | 15 | 60 |
| 549 | 12 | 11 | 0 | — 4 | 15 | II | 35 | 140 |
| 550 | 12 | 15 | 0 | — 4 | 30 | II | 29 | 116 |
| 551 | 12 | 17 | 0 | — 4 | 45 | II | 27 | 108 |
| 552 | 12 | 29 | 0 | — 7 | 45 | II | 28 | 113 |
| 553 | 12 | 34 | 0 | — 6 | 45 | II | 36 | 145 |
| 554 | 12 | 35 | 0 | — 6 | 0 | II | 25 | 101 |
| 555 | 12 | 36 | 0 | — 7 | 0 | II | 24 | 97 |
| 556 | 12 | 37 | 0 | — 6 | 0 | II | 40 | 161 |
| 557 | 12 | 39 | 0 | — 6 | 0 | II | 35 | 141 |
| 558 | 12 | 45 | 0 | — 8 | 30 | II | 19 | 77 |

TABLE III — COUNTS OF STARS — Continued.

| No | R. A. 1860. | | | Dec. 1860. | | Telescope. | No. Stars | 4 Sec. $\delta$ × No. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | ° | ′ | | | |
| 559 | 12 | 47 | 0 | — 8 | 45 | II | 16 | 65 |
| 560 | 12 | 49 | 0 | — 8 | 15 | II | 29 | 117 |
| 561 | 13 | 2 | 0 | —12 | 30 | I | 20 | 82 |
| 562 | 13 | 4 | 0 | —12 | 30 | I | 23 | 94 |
| 563 | 13 | 6 | 0 | —12 | 45 | I | 27 | 110 |
| 564 | 13 | 8 | 0 | —13 | 45 | I | 24 | 99 |
| 565 | 13 | 10 | 0 | —13 | 0 | I | 27 | 111 |
| 566 | 13 | 12 | 0 | —13 | 0 | I | 22 | 91 |
| 567 | 13 | 14 | 0 | —13 | 15 | I | 23 | 95 |
| 568 | 13 | 16 | 0 | —13 | 15 | I | 17 | 70 |
| 569 | 13 | 18 | 0 | —13 | 30 | I | 19 | 78 |
| 570 | 13 | 20 | 0 | —13 | 30 | I | 14 | 58 |
| 571 | 13 | 22 | 0 | +12 | 30 | I | 27 | 110 |
| 572 | 13 | 24 | 0 | +12 | 15 | I | 20 | 82 |
| 573 | 13 | 24 | 0 | +11 | 45 | I | 13 | 53 |
| 574 | 13 | 25 | 0 | —13 | 45 | I | 21 | 86 |
| 575 | 13 | 27 | 0 | —14 | 0 | I | 14 | 58 |
| 576 | 13 | 29 | 0 | —14 | 0 | I | 14 | 58 |
| 577 | 13 | 31 | 0 | —14 | 15 | I | 9 | 37 |
| 578 | 13 | 32 | 0 | +10 | 30 | I | 16 | 65 |
| 579 | 13 | 33 | 0 | +11 | 30 | I | 13 | 53 |
| 580 | 13 | 33 | 0 | +11 | 0 | I | 12 | 49 |
| 581 | 13 | 33 | 0 | —14 | 15 | I | 20 | 82 |
| 582 | 13 | 34 | 0 | +10 | 30 | I | 18 | 73 |
| 583 | 13 | 35 | 0 | +11 | 30 | I | 21 | 86 |
| 584 | 13 | 35 | 0 | +11 | 0 | I | 21 | 86 |
| 585 | 13 | 35 | 0 | —14 | 15 | I | 23 | 95 |
| 586 | 13 | 37 | 0 | +11 | 30 | I | 13 | 54 |

TABLE III—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | | | Dec. 1860. | | Telescope. | No. Stars. | 4 Sec. δ × No. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | ° | ′ | | | |
| 587 | 13 | 37 | 0 | +11 | 0 | I | 12 | 49 |
| 588 | 13 | 39 | 0 | +11 | 0 | I | 16 | 65 |
| 589 | 13 | 44 | 0 | −14 | 45 | I | 14 | 58 |
| 590 | 13 | 46 | 0 | −14 | 45 | I | 16 | 66 |
| 591 | 13 | 48 | 0 | −15 | 0 | I | 17 | 70 |
| 592 | 15 | 49 | 0 | −14 | 45 | I | 17 | 70 |
| 593 | 15 | 49 | 0 | −15 | 15 | I | 16 | 66 |
| 594 | 15 | 51 | 0 | −14 | 45 | I | 18 | 74 |
| 595 | 15 | 53 | 0 | −14 | 45 | I | 17 | 69 |
| 596 | 15 | 53 | 0 | −15 | 15 | I | 11 | 46 |
| 597 | 16 | 2 | 0 | − 6 | 0 | I | 28 | 118 |
| 598 | 16 | 2 | 0 | − 7 | 0 | I | 17 | 69 |
| 499 | 16 | 2 | 0 | − 7 | 30 | I | 21 | 85 |
| 600 | 16 | 2 | 0 | −14 | 45 | I | 25 | 103 |
| 601 | 16 | 2 | 0 | −15 | 15 | I | 33 | 137 |
| 602 | 16 | 2 | 0 | −15 | 45 | I | 25 | 104 |
| 603 | 16 | 2 | 0 | −16 | 15 | I | 23 | 102 |
| 604 | 16 | 2 | 0 | −16 | 45 | I | 35 | 146 |
| 605 | 16 | 3 | 0 | − 6 | 30 | I | 26 | 105 |
| 606 | 16 | 4 | 0 | − 6 | 0 | I | 19 | 77 |
| 607 | 16 | 4 | 0 | − 7 | 0 | I | 24 | 97 |
| 608 | 16 | 4 | 0 | −14 | 45 | I | 29 | 119 |
| 609 | 16 | 4 | 0 | −15 | 15 | I | 28 | 116 |
| 610 | 16 | 4 | 0 | −15 | 45 | I | 26 | 108 |
| 611 | 16 | 5 | 0 | − 6 | 30 | I | 19 | 77 |
| 612 | 16 | 6 | 0 | − 7 | 0 | I | 25 | 101 |
| 613 | 16 | 8 | 0 | − 7 | 0 | I | 20 | 81 |
| 614 | 16 | 10 | 0 | − 7 | 0 | I | 18 | 73 |

TABLE III — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | Telescope. | No. Stars. | 4 Sec. δ × No. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 615 | 16 12 0 | — 6 45 | I | 21 | 85 |
| 616 | 16 14 0 | — 6 45 | I | 20 | 80 |
| 617 | 16 16 0 | — 6 45 | I | 20 | 80 |
| 618 | 16 17 0 | —16 0 | I | 27 | 112 |
| 619 | 16 18 0 | — 6 30 | I | 26 | 105 |
| 620 | 16 19 0 | —16 0 | I | 13 | 54 |
| 621 | 17 42 0 | — 6 15 | II | 71 | 286 |
| 622 | 17 42 0 | — 6 45 | II | 70 | 282 |
| 623 | 17 44 0 | — 6 15 | II | 73 | 294 |
| 624 | 17 44 0 | — 6 45 | II | 59 | 237 |
| 625 | 17 46 0 | — 6 15 | II | 54 | 217 |
| 626 | 17 46 0 | — 6 45 | II | 55 | 221 |
| 627 | 17 48 0 | — 6 45 | II | 54 | 217 |
| 628 | 17 52 0 | — 6 15 | II | 70 | 282 |
| 629 | 17 52 0 | — 6 45 | II | 63 | 254 |
| 630 | 17 54 0 | — 6 15 | II | 43 | 173 |
| 631 | 17 54 0 | — 6 45 | II | 44 | 177 |
| 632 | 17 56 0 | — 6 45 | II | 47 | 189 |
| 633 | 17 58 0 | — 6 45 | II | 44 | 177 |
| 634 | 18 0 0 | — 6 45 | II | 39 | 157 |
| 635 | 18 7 0 | —32 15 | I | 36 | 170 |
| 636 | 18 9 0 | —31 45 | I | 43 | 203 |
| 637 | 18 9 0 | —32 15 | I | 35 | 165 |
| 638 | 18 11 0 | —31 45 | I | 40 | 189 |
| 639 | 18 11 0 | —32 15 | I | 57 | 268 |
| 640 | 19 3 0 | —23 0 | I | 32 | 140 |
| 641 | 19 5 0 | —23 0 | I | 50 | 218 |
| 642 | 19 7 0 | —22 45 | I | 51 | 220 |

TABLE III.—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | | | Dec. 1860. | | Telescope. | No. Stars. | 4 Sec. δ × No. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | ° | ′ | | | |
| 643 | 19 | 9 | 0 | —22 | 45 | I | 60 | 259 |
| 644 | 19 | 16 | 0 | —22 | 15 | I | 73 | 315 |
| 645 | 19 | 18 | 0 | —22 | 15 | I | 42 | 181 |
| 646 | 19 | 21 | 0 | —25 | 0 | II | 61 | 263 |
| 647 | 20 | 32 | 0 | + 1 | 0 | I | 64 | 256 |
| 648 | 20 | 34 | 0 | + 1 | 0 | I | 51 | 204 |
| 649 | 20 | 36 | 0 | + 1 | 15 | I | 40 | 160 |
| 650 | 20 | 38 | 0 | + 1 | 15 | I | 58 | 232 |
| 651 | 20 | 40 | 0 | + 1 | 15 | I | 37 | 148 |
| 652 | 20 | 42 | 0 | + 1 | 15 | I | 32 | 128 |
| 653 | 20 | 44 | 0 | + 1 | 15 | I | 50 | 200 |
| 654 | 20 | 46 | 0 | + 1 | 15 | I | 36 | 144 |
| 655 | 21 | 42 | 0 | —12 | 15 | I | 24 | 98 |
| 656 | 21 | 42 | 0 | —13 | 15 | II | 28 | 115 |
| 657 | 21 | 42 | 0 | —13 | 45 | II | 30 | 124 |
| 658 | 21 | 43 | 0 | —11 | 45 | I | 23 | 94 |
| 659 | 21 | 45 | 0 | —11 | 45 | I | 25 | 102 |
| 660 | 21 | 47 | 0 | —11 | 30 | I | 21 | 86 |
| 661 | 21 | 49 | 0 | —11 | 15 | I | 27 | 110 |
| 662 | 21 | 51 | 0 | —10 | 30 | I | 25 | 102 |
| 663 | 21 | 51 | 0 | —11 | 0 | I | 19 | 77 |
| 664 | 21 | 53 | 0 | —10 | 30 | I | 15 | 61 |
| 665 | 22 | 2 | 0 | + 1 | 0 | I | 14 | 56 |
| 666 | 22 | 4 | 0 | + 1 | 0 | I | 10 | 40 |
| 667 | 22 | 6 | 0 | + 1 | 0 | I | 8 | 32 |
| 668 | 22 | 8 | 0 | + 1 | 0 | I | 11 | 44 |
| 669 | 22 | 10 | 0 | + 1 | 0 | I | 12 | 48 |
| 670 | 22 | 12 | 0 | + 1 | 0 | I | 10 | 40 |

TABLE III — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | Dec. 1860. | Telescope. | No. Stars. | 4 Sec. $\delta$ × No. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 671 | 22 14 0 | + 1 0 | I | 13 | 52 |
| 672 | 22 16 0 | + 1 0 | I | 18 | 72 |
| 673 | 22 18 0 | + 1 0 | I | 24 | 96 |
| 674 | 22 20 0 | + 1 0 | I | 10 | 40 |
| 675 | 22 22 0 | + 2 0 | I | 18 | 72 |
| 676 | 22 22 0 | + 1 30 | I | 28 | 112 |
| 677 | 22 22 0 | + 1 0 | I | 29 | 116 |
| 678 | 22 22 0 | — 1 45 | I | 24 | 96 |
| 679 | 22 22 0 | — 2 15 | I | 24 | 96 |
| 680 | 22 24 0 | + 2 0 | I | 12 | 48 |
| 681 | 22 24 0 | + 1 30 | I | 31 | 124 |
| 682 | 22 24 0 | + 1 0 | I | 32 | 128 |
| 683 | 22 24 0 | — 1 45 | I | 25 | 100 |
| 684 | 22 24 0 | — 2 15 | I | 18 | 72 |
| 685 | 22 26 0 | + 2 0 | I | 13 | 52 |
| 686 | 22 26 0 | + 1 30 | I | 17 | 68 |
| 687 | 22 26 0 | — 1 45 | I | 25 | 100 |
| 688 | 22 26 0 | — 2 15 | I | 29 | 116 |
| 689 | 22 28 0 | + 2 0 | I | 28 | 112 |
| 690 | 22 28 0 | + 1 30 | I | 26 | 104 |
| 691 | 22 28 0 | — 1 45 | I | 23 | 92 |
| 692 | 22 30 0 | + 2 0 | I | 25 | 100 |
| 693 | 22 30 0 | + 1 30 | I | 24 | 96 |
| 694 | 22 30 0 | — 1 15 | I | 21 | 84 |
| 695 | 22 30 0 | — 1 45 | I | 32 | 128 |
| 696 | 22 32 0 | + 2 0 | I | 24 | 96 |
| 697 | 22 32 0 | + 1 30 | I | 24 | 96 |
| 698 | 22 32 0 | — 1 15 | I | 38 | 152 |

TABLE III—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | Telescope. | No. Stars. | 4 Sec. δ × No. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 699 | 22 32 0 | — 1 45 | I | 28 | 112 |
| 700 | 22 34 0 | + 2 0 | I | 29 | 116 |
| 701 | 22 34 0 | + 1 30 | I | 18 | 72 |
| 702 | 22 34 0 | — 1 15 | I | 22 | 88 |
| 703 | 22 35 0 | — 0 45 | I | 22 | 88 |
| 704 | 22 36 0 | + 2 0 | I | 16 | 64 |
| 705 | 22 36 0 | — 1 15 | I | 22 | 88 |
| 706 | 22 37 0 | — 0 45 | I | 10? | 40? |
| 707 | 22 38 0 | + 2 0 | I | 25 | 100 |
| 708 | 22 38 0 | — 1 15 | I | 21 | 84 |
| 709 | 22 39 0 | — 0 45 | I | 22 | 88 |
| 710 | 22 41 0 | — 9 30 | I | 37 | 149 |
| 711 | 22 42 0 | — 0 30 | I | 14 | 56 |
| 712 | 22 42 0 | —12 15 | I | 15 | 60 |
| 713 | 22 43 0 | — 9 30 | I | 19 | 77 |
| 714 | 21 44 0 | — 0 15 | I | 18 | 72 |
| 715 | 22 44 0 | —12 0 | I | 22 | 90 |
| 716 | 22 45 0 | — 9 0 | I | 26 | 105 |
| 717 | 22 46 0 | — 0 15 | I | 26 | 104 |
| 718 | 22 46 0 | —11 45 | I | 13 | 53 |
| 719 | 22 47 0 | — 8 45 | I | 26 | 105 |
| 720 | 22 48 0 | — 0 0 | I | 27 | 108 |
| 721 | 22 48 0 | — 8 0 | I | 21 | 85 |
| 722 | 22 48 0 | —11 30 | I | 15 | 61 |
| 723 | 22 49 0 | — 7 30 | I | 24 | 97 |
| 724 | 22 49 0 | — 8 30 | I | 27 | 109 |
| 725 | 22 49 0 | —11 0 | I | 13 | 52 |
| 726 | 22 50 0 | — 0 0 | I | 16 | 64 |

TABLE III — COUNTS OF STARS — Continued.

| No. | R. A. 1860. | | | Dec. 1860. | | Telescope. | No. Stars. | 4 Sec. $\delta$ × No. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | ° | ′ | | | |
| 727 | 22 | 50 | 0 | —11 | 30 | I | 14 | 57 |
| 728 | 22 | 51 | 0 | —11 | 0 | I | 17 | 69 |
| 729 | 22 | 52 | 0 | — 0 | 0 | I | 12 | 48 |
| 730 | 22 | 52 | 0 | — 1 | 0 | I | 21 | 84 |
| 731 | 22 | 54 | 0 | + 0 | 15 | I | 24 | 96 |
| 732 | 22 | 54 | 0 | — 0 | 15 | I | 14 | 56 |
| 733 | 22 | 56 | 0 | + 0 | 30 | I | 21 | 84 |
| 734 | 22 | 56 | 0 | + 0 | 0 | I | 20 | 80 |
| 735 | 22 | 56 | 0 | — 0 | 30 | I | 23 | 92 |
| 736 | 22 | 58 | 0 | + 0 | 30 | I | 24 | 96 |
| 737 | 22 | 58 | 0 | + 0 | 0 | I | 21 | 84 |
| 738 | 22 | 58 | 0 | — 0 | 30 | I | 20 | 80 |
| 739 | 23 | 0 | 0 | + 0 | 0 | I | 13 | 52 |
| 740 | 23 | 0 | 0 | — 0 | 30 | I | 15 | 60 |
| 741 | 23 | 1 | 0 | + 1 | 15 | I | 17 | 68 |
| 742 | 23 | 1 | 0 | + 0 | 45 | I | 23 | 92 |
| 743 | 23 | 2 | 0 | —10 | 15 | I | 17 | 68 |
| 744 | 23 | 3 | 0 | + 1 | 15 | I | 18 | 72 |
| 745 | 23 | 3 | 0 | + 0 | 45 | I | 29 | 116 |
| 746 | 23 | 4 | 0 | —10 | 0 | I | 19 | 77 |
| 747 | 23 | 5 | 0 | + 1 | 15 | I | 27 | 108 |
| 748 | 23 | 6 | 0 | + 9 | 45 | I | 19 | 77 |
| 749 | 23 | 7 | 0 | + 1 | 45 | I | 21 | 84 |
| 750 | 23 | 7 | 0 | + 1 | 15 | I | 23 | 92 |
| 751 | 23 | 8 | 0 | — 9 | 30 | I | 19 | 77 |
| 752 | 23 | 9 | 0 | + 1 | 45 | I | 20 | 80 |
| 753 | 23 | 9 | 0 | + 1 | 15 | I | 26 | 104 |
| 754 | 23 | 10 | 0 | — 9 | 15 | I | 22 | 89 |

TABLE III.—COUNTS OF STARS—Continued.

| No. | R. A. 1860. | Dec. 1860. | Telescope. | No. Stars. | 4 Sec. $\delta$ × No. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | | |
| 755 | 23 11 0 | + 1 45 | I | 15 | 60 |
| 756 | 23 11 0 | + 1 15 | I | 22 | 88 |
| 757 | 23 12 0 | — 9 15 | I | 18 | 73 |
| 758 | 23 13 0 | + 1 45 | I | 16 | 64 |
| 759 | 23 13 0 | + 1 15 | I | 23 | 92 |
| 760 | 23 14 0 | — 9 0 | I | 21 | 85 |
| 761 | 23 15 0 | + 1 45 | I | 22 | 88 |
| 762 | 23 17 0 | + 1 45 | I | 21 | 84 |
| 763 | 23 18 0 | + 2 15 | I | 22 | 88 |
| 764 | 23 19 0 | + 2 45 | I | 24 | 92 |
| 765 | 23 19 0 | + 1 45 | I | 26 | 104 |
| 766 | 23 20 0 | + 2 15 | I | 31 | 124 |
| 767 | 23 29 0 | — 8 30 | I | 20 | 81 |
| 768 | 23 31 0 | — 8 15 | I | 32 | 129 |
| 769 | 23 33 0 | — 8 15 | I | 37 | 149 |
| 770 | 23 35 0 | — 8 15 | I | 29 | 117 |
| 771 | 23 45 0 | — 6 45 | I | 12 | 48 |
| 772 | 23 45 0 | — 7 15 | I | 18 | 73 |
| 773 | 23 47 0 | — 6 30 | I | 11 | 44 |
| 774 | 23 47 0 | — 7 0 | I | 16 | 64 |
| 775 | 23 49 0 | — 6 15 | I | 17 | 68 |
| 776 | 23 51 0 | — 5 45 | I | 15 | 60 |
| 777 | 23 52 0 | — 5 15 | I | 16 | 64 |
| 778 | 23 53 0 | — 5 45 | I | 10 | 40 |
| 779 | 23 55 0 | — 5 45 | I | 13 | 52 |
| 780 | 23 57 0 | — 5 45 | I | 18 | 72 |
| 781 | 23 59 0 | — 5 45 | I | 11 | 44 |

COUNTS OF STARS FROM PALISA'S PUBLISHED CHARTS, Nos. 2 AND 3, MADE WITH THE 12 INCH REFRACTOR OF VIENNA.

| No. | R. A. 1860. | | Dec. 1860. | No. Stars per 1° | (No. Stars) Sec. δ |
|---|---|---|---|---|---|
| | h. | m. | ° ′ | | |
| 782 | 10 | 2 | +13 30 | 97 | 100 |
| 783 | | 2 | +12 30 | 99 | 101 |
| 784 | | 2 | +11 30 | 88 | 90 |
| 785 | | 2 | +10 30 | 97 | 99 |
| 786 | | 2 | + 9 30 | 99 | 100 |
| 787 | 10 | 6 | +13 30 | 101 | 104 |
| 788 | | 6 | +12 30 | 106 | 108 |
| 789 | | 6 | +11 30 | 128 | 131 |
| 790 | | 6 | +10 30 | 118 | 120 |
| 791 | | 6 | + 9 30 | 102 | 103 |
| 792 | 10 | 10 | +13 30 | 114 | 117 |
| 793 | | 10 | +12 30 | 104 | 106 |
| 794 | | 10 | +11 30 | 100 | 102 |
| 795 | | 10 | +10 30 | 91 | 93 |
| 796 | | 10 | + 9 30 | 100 | 101 |
| 797 | 10 | 14 | +13 30 | 81 | 83 |
| 798 | | 14 | +12 30 | 111 | 113 |
| 799 | | 14 | +11 30 | 100 | 102 |
| 800 | | 14 | +10 30 | 79 | 81 |
| 801 | | 14 | + 9 30 | 109 | 110 |
| 802 | 10 | 18 | +13 30 | 107 | 110 |
| 803 | | 18 | +12 30 | 97 | 99 |
| 804 | | 18 | +11 30 | 120 | 122 |
| 805 | | 18 | +10 30 | 99 | 101 |
| 806 | 10 | 18 | + 9 30 | 114 | 115 |

COUNTS OF STARS FROM PALISA'S PUBLISHED CHARTS, NOS. 2 AND 3—Continued.

| No. | R. A. 1860, | Dec. 1860. | No. Stars per 1° | (No. Stars) Sec. $\delta$ |
|---|---|---|---|---|
| | h. m. | ° ′ | | |
| 807 | 12 22 | + 4 15 | 112 | 112 |
| 808 | 22 | + 3 15 | 132 | 132 |
| 807 | 22 | + 2 15 | 137 | 137 |
| 810 | 22 | + 1 15 | 124 | 124 |
| 811 | 22 | + 0 15 | 122 | 122 |
| 812 | 12 26 | + 4 15 | 122 | 122 |
| 813 | 26 | + 3 15 | 117 | 117 |
| 814 | 26 | + 2 15 | 114 | 114 |
| 815 | 26 | + 1 15 | 117 | 117 |
| 816 | 26 | + 0 15 | 136 | 136 |
| 817 | 12 30 | + 4 15 | 122 | 122 |
| 818 | 30 | + 3 15 | 127 | 127 |
| 819 | 30 | + 2 15 | 123 | 123 |
| 820 | 30 | + 1 15 | 138 | 138 |
| 821 | 30 | + 0 15 | 105 | 105 |
| 822 | 12 34 | + 4 15 | 109 | 109 |
| 823 | 34 | + 3 15 | 121 | 121 |
| 824 | 34 | + 2 15 | 138 | 138 |
| 825 | 34 | + 1 15 | 119 | 119 |
| 826 | 34 | + 0 15 | 141 | 141 |
| 827 | 12 38 | + 4 15 | 129 | 129 |
| 828 | 38 | + 3 15 | 121 | 121 |
| 829 | 38 | + 2 15 | 113 | 113 |
| 830 | 38 | + 1 15 | 120 | 120 |
| 831 | 38 | + 0 15 | 113 | 113 |

COUNTS OF STARS FROM PALISA'S PUBLISHED CHART IN 22 HOURS MADE WITH THE 6-INCH REFRACTOR AT POLA.

| No. | R. A. 1860. | Dec. 1860. | No. Stars per 1°. | No. Stars Sec. $\delta$. |
|---|---|---|---|---|
| | h. m. | ° ′ | | |
| 832 | 22 2 | —13 30 | 133 | 137 |
| 833 | 2 | —12 30 | 129 | 132 |
| 834 | 2 | —11 30 | 139 | 142 |
| 835 | 2 | —10 30 | 157 | 160 |
| 836 | 2 | — 9 30 | 133 | 134 |
| 837 | 22 6 | —13 30 | 154 | 159 |
| 838 | 6 | —12 30 | 117 | 119 |
| 839 | 6 | —11 30 | 135 | 138 |
| 840 | 6 | —10 30 | 134 | 137 |
| 841 | 6 | — 9 30 | 142 | 143 |
| 842 | 22 10 | —13 30 | 150 | 155 |
| 843 | 10 | —12 30 | 121 | 123 |
| 844 | 10 | —11 30 | 134 | 137 |
| 845 | 10 | —10 30 | 120 | 122 |
| 846 | 10 | — 9 30 | 130 | 131 |
| 847 | 22 14 | —13 30 | 128 | 132 |
| 848 | 14 | —12 30 | 120 | 122 |
| 849 | 14 | —11 30 | 116 | 118 |
| 850 | 14 | —10 30 | 101 | 103 |
| 851 | 14 | — 9 30 | 142 | 143 |
| 852 | 22 18 | —13 30 | 117 | 121 |
| 853 | 18 | —12 30 | 110 | 112 |
| 854 | 18 | —11 30 | 123 | 125 |
| 855 | 18 | —10 30 | 124 | 126 |
| 856 | 18 | — 9 30 | 124 | 125 |

The data of the preceding tables may be combined in various ways. I conceive that the presentation of the immediate and crude results of observation will not be unwelcome to astronomers. Tables A and B, immediately following, summarize them as follows: In Table A the first column gives the authority; the second, the number of gauges, or counts; the third, the number of separate pointings of the telescope; the fourth, the total number of stars counted (for PALISA and PETERS, the *actual* number of stars counted in each $4^m$ of R. A. by 1° in Dec., has been multiplied by Sec. $\delta$ before making the summation.); the fifth, the average number of stars per count, or gauge; the sixth, the average number of stars per square degree of a great circle; the seventh, the limits of magnitude (approximate) of the stars counted; the eighth, the number of stars down to each certain magnitude, which would be scattered over the whole surface of the sky, *provided,* the distribution over the whole sky was the same as that in the special area counted; the ninth, the *limits* of declination of the special areas considered (the *limits* of R. A. being $0^h$ and $24^h$ in each case, though the whole $24^h$ in R. A. is only investigated in the first 8 horizontal lines); and the tenth, the actual number of square degrees which have been counted, and upon which the numbers in the eighth column depend.

The table furnishes several simple proofs that the stars cannot be regarded as equably distributed in space. The gauges of the elder HERSCHEL, numbers 13 and 14, for example, may be taken as two fairly comparable determinations of the same quantity. Any satisfactory formula should cover these two cases, as indeed it should cover the gauges of SIR JOHN HERSCHEL. The first two determinations (Series I and II) differ from each other by over 30 *per cent.* of the smaller, and hence no expression of the form $\Sigma_m = a\, b^m$ will serve to represent the numbers of col. 8 throughout, though such a one may serve as far as the 11 mag. The limiting magnitudes in col. 7 will be fixed by the photometric determinations of the Harvard College Observatory, except perhaps those corresponding to the HERSCHEL gauges.

TABLE A — STATISTICS OF STAR-GAUGES.

| Authority. | Number of counts or gauges. | Number of fields. | Total number of stars counted. | Average number of stars per count or gauge. | Average number of stars per 1° square. | Limits of magnitude. | Proportional numbr of stars in the whole sky. | Limits of declination of the counts. | Number of square degrees actually counted. |
|---|---|---|---|---|---|---|---|---|---|
| No. | | | | | | | | ° ° | |
| 1. ARGELANDER; Uran. Nova. | ..... | ..... | 2,352 | ..... | 0.11 | 1— 6? | 4,704 | +90; 0 | 20,626.5 |
| 2. BEHRMANN; Atlas. | ..... | ..... | 2,328 | ..... | 0.17 | 1— 6? | 6,964 | —20;—90 | 13,790. |
| 3. HOUZEAU; Uran. Gen. | ..... | ..... | 5,719 | ..... | 0.14 | 1— 6? | 5,719 | +90;—90 | 41,253. |
| 4. HEIS; Atlas Coel. | ..... | ..... | 3,903 | ..... | 0.19 | 1— 6.5? | 7,806 | +90; 0 | 20,626.5 |
| 5. GOULD; Uran. Arg. | ..... | ..... | 6,694 | ..... | 0.32 | 1— 7.0? | 13,388 | 0;—90 | 20,626.5 |
| 6. ARGELANDER; DM. | ..... | ..... | 25,321 | ..... | 1.23 | 1— 8.0? | 50,642 | +90;— 0 | 20,626.5 |
| 7. ARGELANDER; DM. | ..... | ..... | 324,198 | ..... | 15.19 | 1—10. ? | 626,630 | +90;— 2 | 21,344.7 |
| 8. CELORIA; Pub. Milan XIII. | ..... | 27,216 | 200,781 | ..... | 93.12 | 1—11. ? | 3,841,650 | + 6; 0 | 2,156.5 |
| 9. PALISA; Ms. and pub. (Pola.) | 628 | ..... | 62,774 | ..... | 99.96 | 1—13. ? | 4,123,600 | +28;—32 | 175 ± |
| 10. PALISA; Ms. and published (Vienna). | 228 | ..... | 29,574 | ..... | 129.71 | 1—14.6? | 5,350,900 | +29;—25 | 94 ± |
| 11. PETERS; Ms. maps (only). | 954 | ..... | 68,410 | ..... | 71.71 | 1—14.8? | 2,958,200 | +25;—26 | 950 ± |
| 12. PETERS; published maps. | 500 | ..... | 43,928 | ..... | 87.87 | 1—14.9? | 3,624,800 | +20;—25 | 500 ± |
| 13. W. HERSCHEL; Series I. (published). | 683 | 3,400 | 27,989 | 40.98 | 827.46 | 1—15. ? | 34,135,000 | +46;—32 | 168.3 |
| 14. W. HERSCHEL; Series II. (unpublished). | 405 | 2,245 | 21,964 | 54.23 | 1095.1 | 1—15. ? | 45,174,000 | +81;—32 | 111.2 |
| 15. J. HERSCHEL; C. G. H. | 605 | 2,299 | 68,948 | 113.96 | 2301.2 | 1—15. ? | 94,929,000 | 0;—90 | 113.9 |
| 16. W. and J. HERSCHEL; all observed. | 1,693 | 7,944 | 118,882 | 70.22 | 1417.9 | 1—15. ? | 58,492,000 | +81;—90 | 393.4 |

In table A it is clear that the irregularity of the distribution of the stars in R. A. in the various series has influenced the Nos. of col. 8 so that they are not comparable. The numbers for PALISA'S 6 inch telescope are greater than those for PETERS. The table B gives similar data for certain of the authorities for every $20^m$ of R. A. throughout the $24^h$. All the counts refer to 1860.0, except those of ARGELANDER, which are given for 1855.0.

Column 1 gives the limits of R. A.; column 2 gives the average number of stars from the first to the tenth magnitude, in the *Durchmusterung*, quoted from the Bonn observations, vol. 5; column 3 gives the number of counts of areas of $2^m$ in R. A. by 30′, made by DR. PALISA on his Pola maps, and column 5 the same datum for his Vienna maps (these include both published and unpublished maps); column 4 gives the number of stars per 1° square derived from the Pola maps, and column 6 the same quantity for the Vienna maps; these numbers are the sum of the quantities 4 sec. $\delta$ times the *actual* number of stars, divided by the number of counts; column 7 gives the number of square degrees counted on DR. PETERS' ms. maps (not including a very few of Professor WATSON'S), and column 8 gives the average number of stars per 1° square for PETERS', derived as above; column 9 gives the number of gauges (not fields) counted by SIR W. HERSCHEL within the R. A.'s noted, and column 10 gives the number of stars per 1° square for HERSCHEL.

The limits of declination are given in Table A. I have not included Sir J. HERSCHEL'S gauges, as they refer to the southern hemisphere only, while the others refer partly to the northern sky.

The last four columns of the table give the ratios:—

No. of stars per 1° (HERSCHEL) divided by No. of stars per 1° for ARGELANDER, PALISA (Pola), PALISA (Vienna) and PETERS, respectively.

These ratios show again how far from uniform is the scattering of the stars. While it is true that the problem of the true distribution of the stars, if it is to be solved at all, must be solved by neglecting the individual peculiarities of small regions, yet it appears to be evident from the table, that areas much smaller than 20 *m.* in R. A. by 92° in declination must be considered. I have taken them so large in this table only because the counts for the *Durchmusterung* are given to every 20 *m.*

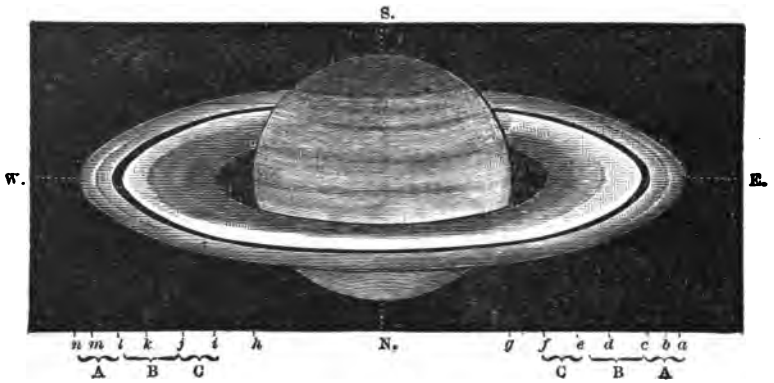
TABLE B—STATISTICS OF STAR GAUGES.

| Limiting R. A. 1860.0 | | | | | Argelander, D. M. No. of Stars per 1° 1–10 mags. | Palisa's Pola Maps. | | Palisa's Vienna Maps. | | Peters' Ms. Maps. | | W. Herschel's Gauges. | | Herschel ÷ Argelander. | Herschel ÷ Palisa (Pola). | Herschel ÷ Palisa (Vienna). | Herschel ÷ Peters (ms.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | No. of ¼ degrees counted. | No. of Stars per 1°. 1—13? mags. | No. of ¼ Degrees counted. | No. of Stars per 1°. 1—14.6? mags. | No. of degrees counted. | No. of Stars per 1°. 1—14.8 mags. | No. of Gauges. | No. of Stars per 1°. 1—15? mags. | | | | |
| h. | m. | | h. | m. | | | | | | | | | | | | | |
| 0 | 0 | to | 0 | 20 | 15.9 | 29 | 76. | 13 | 104.8 | 45 | 53.7 | 12 | 240 | 15.1 | 3.2 | 2.3 | 4.5 |
| 0 | 20 | to | 0 | 40 | 15.9 | 1 | 61. | ..... | ..... | ..... | ..... | 8 | 481 | 30.3 | 7.9 | ..... | ..... |
| 0 | 40 | to | 1 | 0 | 15.7 | ..... | ..... | ..... | ..... | 40 | 62.1 | 12 | 459 | 29.2 | ..... | ..... | 7.4 |
| 1 | 0 | to | 2 | 20 | 15.3 | ..... | ..... | ..... | ..... | 50 | 71.0 | 21 | 313 | 20.5 | ..... | ..... | 4.4 |
| 1 | 20 | to | 1 | 40 | 15.9 | ..... | ..... | 10 | 93. | 15 | 60.3 | 9 | 436 | 27.4 | ..... | 4.7 | 7.2 |
| 1 | 40 | to | 2 | 0 | 15.5 | 9 | 80.9 | 36 | 87.9 | 12 | 72.5 | 9 | 166 | 10.7 | 2.1 | 1.9 | 2.3 |
| 2 | 0 | to | 2 | 20 | 15.2 | 15 | 67.9 | 3 | 90. | ..... | ..... | 9 | 160 | 10.5 | 2.4 | 1.8 | ..... |
| 2 | 20 | to | 2 | 40 | 14.7 | 53 | 84.2 | ..... | ..... | ..... | ..... | 16 | 487 | 33.1 | 5.8 | ..... | ..... |
| 2 | 40 | to | 3 | 0 | 13.3 | 24 | 80.0 | ..... | ..... | ..... | ..... | 10 | 198 | 14.9 | 2.5 | ..... | ..... |
| 3 | 0 | to | 3 | 20 | 13.5 | 8 | 56.5 | 19 | 136.3 | 25 | 86.8 | 8 | 129 | 9.6 | 2.3 | 0.9 | 1.5 |
| 3 | 20 | to | 3 | 40 | 13.4 | 17 | 86.8 | 5 | 128. | ..... | ..... | 12 | 267 | 19.9 | 3.1 | 2.1 | ..... |
| 3 | 40 | to | 4 | 0 | 13.1 | 14 | 112.6 | ..... | ..... | ..... | ..... | 11 | 285 | 21.8 | 2.5 | ..... | ..... |
| 4 | 0 | to | 4 | 20 | 12.7 | 9 | 102. | ..... | ..... | 25 | 70.5 | 11 | 164 | 12.9 | 1.6 | ..... | 2.3 |
| 4 | 20 | to | 4 | 40 | 12.9 | 16 | 108.5 | ..... | ..... | ..... | ..... | 15 | 287 | 22.2 | 2.6 | ..... | ..... |
| 4 | 40 | to | 5 | 0 | 16.3 | 8 | 108.1 | ..... | ..... | 25 | 123.0 | 10 | 372 | 22.8 | 3.4 | ..... | 3.0 |
| 5 | 0 | to | 5 | 20 | 18.7 | 1 | 157. | ..... | ..... | ..... | ..... | 11 | 709 | 37.9 | 4.5 | ..... | ..... |
| 5 | 20 | to | 5 | 40 | 21.1 | ..... | ..... | ..... | ..... | ..... | ..... | 14 | 739 | 35.0 | ..... | ..... | ..... |
| 5 | 40 | to | 6 | 0 | 21.6 | 6 | 204.8 | ..... | ..... | ..... | ..... | 28 | 1,182 | 54.7 | 5.8 | ..... | ..... |
| 6 | 0 | to | 6 | 20 | 22.6 | ..... | ..... | ..... | ..... | ..... | ..... | 34 | 1,420 | 62.8 | ..... | ..... | ..... |
| 6 | 20 | to | 6 | 40 | 22.8 | 4 | 294.5 | ..... | ..... | ..... | ..... | 28 | 1,295 | 56.8 | 4.4 | ..... | ..... |
| 6 | 40 | to | 7 | 0 | 22.0 | 8 | 341.4 | ..... | ..... | ..... | ..... | 36 | 1,683 | 76.5 | 4.9 | ..... | ..... |
| 7 | 0 | to | 7 | 20 | 18.9 | ..... | ..... | ..... | ..... | ..... | ..... | 25 | 1,810 | 95.8 | ..... | ..... | ..... |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 20 | to | 7 | 40 | 16.8 | 6 | 185. | ..... | ..... | ..... | ..... | 25 | 1,974 | 117.5 | 10.7 | ..... | ..... |
| 7 | 40 | to | 8 | 0 | 15.6 | 17 | 183.4 | 10 | 187. | 2 | 130.5 | 17 | 1,921 | 123.1 | 10.5 | 10.3 | 14.7 |
| 8 | 0 | to | 8 | 20 | 14.4 | 8 | 182. | 25 | 224.5 | ..... | ..... | 12 | 1,380 | 95.9 | 7.6 | 5.1 | ..... |
| 8 | 20 | to | 8 | 40 | 13.2 | ..... | ..... | ..... | ..... | 16 | 80.8 | 6 | 652 | 49.4 | ..... | ..... | 8.1 |
| 8 | 40 | to | 9 | 0 | 12.2 | 2 | 107. | ..... | ..... | 16 | 67.5 | 15 | 382 | 31.3 | 3.6 | ..... | 5.7 |
| 9 | 0 | to | 9 | 20 | 11.2 | 16 | 70.8 | ..... | ..... | 20 | 62.7 | 6 | 444 | 39.6 | 6.3 | ..... | 7.1 |
| 9 | 20 | to | 9 | 40 | 10.4 | 57 | 80.1 | 19 | 80.2 | 16 | 62.0 | 7 | 291 | 27.9 | 3.6 | 3.6 | 4.7 |
| 9 | 40 | to | 10 | 0 | 10.1 | 9 | 107.7 | 3 | 98.7 | 21 | 66.3 | 11 | 236 | 23.4 | 2.2 | 2.4 | 3.6 |
| 10 | 0 | to | 10 | 20 | 9.7 | 25 | 91. | 25 | 104.4 | 25 | 76.7 | 4 | 222 | 22.9 | 2.4 | 2.1 | 2.9 |
| 10 | 20 | to | 10 | 40 | 9.0 | 7 | 82.3 | ..... | ..... | 15 | 55.3 | 9 | 143 | 15.9 | 1.7 | ..... | 2.6 |
| 10 | 40 | to | 11 | 0 | 9.2 | 1 | 44. | ..... | ..... | 15 | 72.2 | 4 | 232 | 25.2 | 5.3 | ..... | 3.2 |
| 11 | 0 | to | 11 | 20 | 8.5 | 20 | 77.9 | 6 | 97.8 | 45 | 54.8 | 6 | 156 | 18.4 | 2.0 | 1.6 | 2.8 |
| 11 | 20 | to | 11 | 40 | 8.8 | 9 | 72. | ..... | ..... | 36 | 58.3 | 7 | 133 | 15.1 | 1.9 | ..... | 2.3 |
| 11 | 40 | to | 12 | 0 | 8.3 | ..... | ..... | ..... | ..... | 44 | 57.5 | 3 | 135 | 16.4 | ..... | ..... | 2.3 |
| 12 | 0 | to | 12 | 20 | 8.4 | ..... | ..... | 3 | 121.3 | 75 | 59.8 | 4 | 121 | 14.4 | ..... | 1.0 | 2.0 |
| 12 | 20 | to | 12 | 40 | 8.8 | ..... | ..... | 31 | 123.5 | 5 | 58.6 | 6 | 145 | 16.5 | ..... | 1.2 | 2.5 |
| 12 | 40 | to | 13 | 0 | 8.7 | ..... | ..... | 3 | 86.3 | 4 | 59.5 | 5 | 133 | 15.3 | ..... | 1.5 | 2.2 |
| 13 | 0 | to | 13 | 20 | 8.5 | 9 | 92.2 | ..... | ..... | ..... | ..... | 8 | 133 | 15.7 | 1.4 | ..... | ..... |
| 13 | 20 | to | 13 | 40 | 8.9 | 19 | 68.4 | ..... | ..... | 5 | 70. | 10 | 152 | 17.1 | 2.2 | ..... | 2.2 |
| 13 | 40 | to | 14 | 0 | 8.9 | 3 | 64.7 | ..... | ..... | 25 | 74.8 | 9 | 168 | 18.9 | 2.6 | ..... | 2.2 |
| 14 | 0 | to | 14 | 20 | 9.4 | ..... | ..... | ..... | ..... | 25 | 83.6 | 11 | 202 | 21.5 | ..... | ..... | 2.4 |
| 14 | 20 | to | 14 | 40 | 9.4 | ..... | ..... | ..... | ..... | ..... | ..... | 8 | 192 | 20.4 | ..... | ..... | ..... |
| 14 | 40 | to | 15 | 0 | 9.6 | ..... | ..... | ..... | ..... | ..... | ..... | 12 | 202 | 21.1 | ..... | ..... | ..... |
| 15 | 0 | to | 15 | 20 | 9.6 | ..... | ..... | ..... | ..... | ..... | ..... | 10 | 166 | 17.3 | ..... | ..... | ..... |
| 15 | 20 | to | 15 | 40 | 10.0 | ..... | ..... | ..... | ..... | 5 | 96.8 | 19 | 206 | 20.6 | ..... | ..... | 2.1 |
| 15 | 40 | to | 16 | 0 | 10.7 | 5 | 65. | ..... | ..... | 5 | 102.2 | 17 | 295 | 27.6 | 4.5 | ..... | 2.9 |
| 16 | 0 | to | 16 | 20 | 11.7 | 24 | 90.4 | ..... | ..... | ..... | ..... | 19 | 180 | 15.4 | 2.0 | ..... | ..... |
| 16 | 20 | to | 16 | 40 | 12.0 | ..... | ..... | ..... | ..... | ..... | ..... | 17 | 331 | 27.5 | ..... | ..... | ..... |
| 16 | 40 | to | 17 | 0 | 12.9 | ..... | ..... | ..... | ..... | ..... | ..... | 11 | 432 | 33.5 | ..... | ..... | ..... |
| 17 | 0 | to | 17 | 20 | 13.3 | ..... | ..... | ..... | ..... | ..... | ..... | 8 | 537 | 40.4 | ..... | ..... | ..... |
| 17 | 20 | to | 17 | 40 | 16.0 | ..... | ..... | ..... | ..... | ..... | ..... | 9 | 497 | 31.0 | ..... | ..... | ..... |
| 17 | 40 | to | 18 | 0 | 17.4 | ..... | ..... | 13 | 231.2 | ..... | ..... | 12 | 1,081 | 62.1 | ..... | 4.7 | ..... |
| 18 | 0 | to | 18 | 20 | 20.3 | 5 | 199. | 1 | 157. | ..... | ..... | 20 | 1,563 | 77.0 | 7.9 | 10.0 | ..... |
| 18 | 20 | to | 18 | 40 | 21.6 | ..... | ..... | ..... | ..... | ..... | ..... | 36 | 1,018 | 47.1 | ..... | ..... | ..... |
| 18 | 40 | to | 19 | 0 | 22.9 | ..... | ..... | ..... | ..... | ..... | ..... | 31 | 2,266 | 97.2 | ..... | ..... | ..... |
| 19 | 0 | to | 29 | 20 | 23.5 | 6 | 222.2 | ..... | ..... | 10 | 200.3 | 23 | 2,772 | 113.7 | 12.0 | ..... | 13.4 |

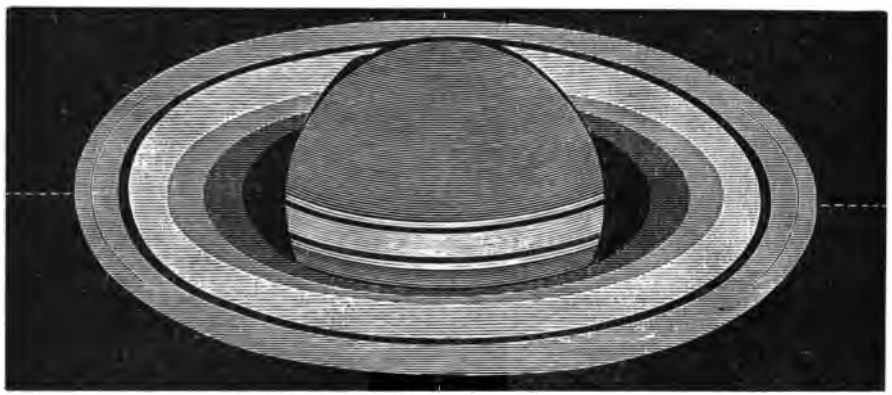
TABLE B—STATISTICS OF STAR GUAGES—Continued.

| Limiting R. A. 1860.0. | | | | | ARGELANDER, D. M. No. of Stars per 1°.1—10 Mags. | PALISA'S Pola Maps. | | PALISA'S Vienna Maps. | | PETERS' Ms. Maps. | | W. HERSCHEL'S Gauges. | | HERSCHEL ÷ ARGELANDER. | HERSCHEL ÷ PALISA (Pola.) | HERSCHEL ÷ PALISA (Vienna.) | HERSCHEL ÷ PETERS', Ms.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | No. of ¼ Degrees counted. | No. of Stars per 1°. 1—13 ?. Mags. | No. of ¼ Degrees counted. | No. of Stars per 1°. 1—14.6 ?. Mags. | No. of Degrees counted. | No. of Stars per 1°. 1—14 8?. Mags. | Number of Gauges. | No. of Stars per 1°. 1—15 ?. Mags. | | | | |
| h. | m. | | h. | m. | | | | | | | | | | | | | |
| 19 | 20 | to | 19 | 40 | 26.6 | ..... | ..... | 1 | 263. | ..... | ..... | 42 | 4,547 | 170.9 | ..... | 17.3 | ..... |
| 19 | 40 | to | 20 | 0 | 27.5 | ..... | ..... | ..... | ..... | ..... | ..... | 37 | 4,153 | 151.0 | ..... | ..... | ..... |
| 20 | 0 | to | 20 | 20 | 25.8 | ..... | ..... | ..... | ..... | 5 | 132.4 | 33 | 2,165 | 83.9 | ..... | ..... | 16.4 |
| 20 | 20 | to | 20 | 40 | 23.7 | 4 | 213. | ..... | ..... | 5 | 97.0 | 25 | 1,370 | 57.8 | 6.4 | ..... | 14.1 |
| 20 | 40 | to | 21 | 0 | 22.0 | 4 | 155. | ..... | ..... | 5 | 78.2 | 27 | 1,927 | 87.6 | 12.4 | ..... | 24.7 |
| 21 | 0 | to | 21 | 20 | 20.6 | ..... | ..... | ..... | ..... | 25 | 81.4 | 23 | 1,505 | 73.0 | ..... | ..... | 18.5 |
| 21 | 20 | to | 21 | 40 | 19.8 | ..... | ..... | ..... | ..... | 49 | 91.0 | 15 | 964 | 48.7 | ..... | ..... | 10.6 |
| 21 | 40 | to | 22 | 0 | 18.7 | 8 | 92.5 | 2 | 119.5 | 31 | 86.7 | 15 | 1,376 | 73.6 | 14.9 | 11.5 | 15.9 |
| 22 | 0 | to | 22 | 20 | 18.7 | 34 | 111.1 | ..... | ..... | 50 | 76.8 | 16 | 503 | 26.9 | 4.5 | ..... | 6.6 |
| 22 | 20 | to | 22 | 40 | 18.2 | 36 | 29.8 | ..... | ..... | 25 | 65.0 | 12 | 176 | 9.7 | 1.9 | ..... | 2.7 |
| 22 | 40 | to | 23 | 0 | 17.4 | 29 | 81.8 | ..... | ..... | 25 | 59.8 | 13 | 297 | 17.1 | 3.6 | ..... | 5.0 |
| 23 | 0 | to | 23 | 20 | 16.1 | 27 | 82.4 | ..... | ..... | 17 | 66.1 | 17 | 214 | 13.3 | 2.6 | ..... | 3.2 |
| 23 | 20 | to | 23 | 40 | 16.1 | 5 | 120. | ..... | ..... | 30 | 53.7 | 11 | 131 | 8.1 | 1.1 | ..... | 2.4 |
| 23 | 40 | to | 24 | 0 | 15.5 | 11 | 57.2 | ..... | ..... | 20 | 62.1 | 10 | 234 | 15.1 | 4.1 | ..... | 3.8 |
| **Sums** ..... | | | | | | 628 | 5113.1 | 228 | 2534.4 | 954 | 3280.3 | 1088 | 53,797 | | | | |
| **Weighted means** ..... | | | | | 15.19 (72) | | 116.2 (44) | | 133.4 (19) | | 80.1 (41) | | 747.2 (72) | | | | |




SATURN.

(1881, NOVEMBER 27.)



SATURN.

(1883, DECEMBER 2.)

# XIII. TABLE OF PRECESSIONS IN RIGHT ASCENSION AND DECLINATION FOR 1880.0.

These tables were prepared at the Washburn Observatory by Mr. GEORGE C. COMSTOCK, and they are printed in the hope that they may be found generally useful.

Within the limits of declination ± 20° the precessions in R. A. were copied from the table given in *Publicationen des Astrophysikalischen Observatoriums zu Potsdam, Dritter Band*, pp. 222–225. The remainder of the precessions were computed from the formulæ,

$$\triangle \alpha = m + n \sin \alpha \operatorname{tg} \delta. \qquad \triangle \delta = n \cos \alpha$$

using the STRUVE-PETERS constants. For 1880.0

$$m = 3^{s}.0723. \qquad \log n = 1.30220.$$

The variation in 100 years of the precession in R. A. for a given $\alpha$ and $\delta$ may be found approximately by dividing the precession in R. A. for $\alpha$ and $-\delta$ by 1750.

The corresponding variation of the precession in declination is $-\frac{1}{2500}$ (the precession in declination).

TABLE OF PRECESSIONS IN DECLINATION FOR 1880.0

| R. A. | | | | Precession | R. A. | | | |
|---|---|---|---|---|---|---|---|---|
| h. | m. | h. | m. | ″ | h. | m. | h. | m. |
| 0 | 0 | 24 | 0 | +20.05— | 12 | 0 | 12 | 0 |
| | 10 | 23 | 50 | 20.04 | | 10 | 11 | 50 |
| | 20 | | 40 | 19.98 | | 20 | | 40 |
| | 30 | | 30 | 19.88 | | 30 | | 30 |
| | 40 | | 40 | 19.75 | | 40 | | 20 |
| | 50 | | 10 | 19.58 | | 50 | | 10 |
| 1 | 0 | 23 | 0 | +19.37— | 13 | 0 | 11 | 0 |
| | 10 | 22 | 50 | 19.13 | | 10 | 10 | 50 |
| | 20 | | 40 | 18.84 | | 20 | | 40 |
| | 30 | | 30 | 18.53 | | 30 | | 30 |
| | 40 | | 20 | 18.18 | | 40 | | 20 |
| | 50 | | 10 | 17.79 | | 50 | | 10 |
| 2 | 0 | 22 | 0 | +17.37— | 14 | 0 | 10 | 0 |
| | 10 | 21 | 50 | 16.91 | | 10 | 9 | 50 |
| | 20 | | 40 | 16.43 | | 20 | | 40 |
| | 30 | | 30 | 15.91 | | 30 | | 30 |
| | 40 | | 20 | 15.36 | | 40 | | 20 |
| | 50 | | 10 | 14.79 | | 50 | | 10 |
| 3 | 0 | 21 | 0 | +14.18— | 15 | 0 | 9 | 0 |
| | 10 | 20 | 50 | 13.55 | | 10 | 8 | 50 |
| | 20 | | 40 | 12.89 | | 20 | | 40 |
| | 30 | | 30 | 12.21 | | 30 | | 30 |
| | 40 | | 20 | 11.50 | | 40 | | 20 |
| | 50 | | 10 | 10.77 | | 50 | | 10 |
| 4 | 0 | 20 | 0 | +10.03— | 16 | 0 | 8 | 0 |
| | 10 | 19 | 50 | 9.26 | | 10 | 7 | 50 |
| | 20 | | 40 | 8 48 | | 20 | | 40 |
| | 30 | | 30 | 7.67 | | 30 | | 30 |
| | 40 | | 20 | 6.86 | | 40 | | 20 |
| | 50 | | 10 | 6.03 | | 50 | | 10 |
| 5 | 0 | 19 | 0 | + 5.19— | 17 | 0 | 7 | 0 |
| | 10 | 18 | 50 | 4.34 | | 10 | 6 | 50 |
| | 20 | | 40 | 3.48 | | 20 | | 40 |
| | 30 | | 30 | 2.62 | | 30 | | 30 |
| | 40 | | 20 | 1.75 | | 40 | | 20 |
| | 50 | | 10 | 0.87 | | 50 | | 10 |
| 6 | 0 | 18 | 0 | + 0.00— | 18 | 0 | 6 | 0 |

## 0.° TABLE OF PRECESSIONS IN R. A. FOR 1880.0.

| R. A. for + δ | | | | 0° | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | R. A. for − δ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| h. | m. | h. | m. | s | s | s | s | s | s | s | s | s | s | s | h. m. | h. m. |
| 0 | 0 | 12 | 0 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 12 0 | 24 0 |
| | 10 | 11 | 50 | .072 | .073 | .074 | .075 | .076 | .077 | .078 | .080 | .081 | .082 | .083 | 10 | 23 50 |
| | 20 | | 40 | .072 | .074 | .076 | .078 | .080 | .082 | .084 | .087 | .089 | .091 | .093 | 20 | 40 |
| | 30 | | 30 | .072 | .075 | .078 | .081 | .084 | .087 | .090 | .094 | .097 | .100 | .103 | 30 | 30 |
| | 40 | | 20 | .072 | .076 | .080 | .084 | .088 | .092 | .096 | .101 | .105 | .109 | .113 | 40 | 20 |
| | 50 | | 10 | .072 | .077 | .082 | .087 | .092 | .097 | .102 | .108 | .113 | .118 | .123 | 50 | 10 |
| 1 | 0 | 11 | 0 | 3.072 | 3.078 | 3.084 | 3.090 | 3.096 | 3.102 | 3.108 | 3.115 | 3.121 | 3.127 | 3.133 | 13 0 | 23 0 |
| | 10 | 10 | 50 | .072 | .079 | .086 | .093 | .100 | .107 | .114 | .122 | .129 | .136 | .143 | 10 | 22 50 |
| | 20 | | 40 | .072 | .080 | .088 | .096 | .104 | .112 | .120 | .128 | .136 | .144 | .152 | 20 | 40 |
| | 30 | | 30 | .072 | .081 | .090 | .099 | .108 | .117 | .126 | .135 | .144 | .153 | .162 | 30 | 30 |
| | 40 | | 20 | .072 | .082 | .092 | .102 | .111 | .121 | .131 | .141 | .151 | .161 | .171 | 40 | 20 |
| | 50 | | 10 | .072 | .083 | .094 | .105 | .115 | .126 | .137 | .148 | .159 | .170 | .181 | 50 | 10 |
| 2 | 0 | 10 | 0 | 3.072 | 3.084 | 3.095 | 3.107 | 3.118 | 3.130 | 3.142 | 3.154 | 3.166 | 3.178 | 3.190 | 14 0 | 22 0 |
| | 10 | 9 | 50 | .072 | .085 | .097 | .110 | .122 | .135 | .147 | .160 | .173 | .186 | .199 | 10 | 21 50 |
| | 20 | | 40 | .072 | .086 | .099 | .112 | .125 | .139 | .152 | .166 | .180 | .193 | .207 | 20 | 40 |
| | 30 | | 30 | .072 | .087 | .101 | .115 | .129 | .143 | .157 | .172 | .187 | .201 | .215 | 30 | 30 |
| | 40 | | 20 | .072 | .087 | .102 | .117 | .132 | .147 | .162 | .178 | .193 | .208 | .223 | 40 | 20 |
| | 50 | | 10 | .072 | .088 | .104 | .120 | .135 | .151 | .167 | .183 | .199 | .215 | .231 | 50 | 10 |
| 3 | 0 | 9 | 0 | 3.072 | 3.089 | 3.105 | 3.122 | 3.138 | 3.155 | 3.171 | 3.188 | 3.205 | 3.222 | 3.238 | 15 0 | 21 0 |
| | 10 | 8 | 50 | .072 | .090 | .107 | .124 | .141 | .159 | .176 | .193 | .211 | .228 | .245 | 10 | 20 50 |
| | 20 | | 40 | .072 | .090 | .108 | .126 | .144 | .162 | .180 | .198 | .216 | .234 | .252 | 20 | 40 |
| | 30 | | 30 | .072 | .091 | .109 | .128 | .147 | .165 | .184 | .202 | .221 | .240 | .259 | 30 | 30 |
| | 40 | | 20 | .072 | .091 | .110 | .130 | .149 | .168 | .187 | .206 | .226 | .245 | .265 | 40 | 20 |
| | 50 | | 10 | .072 | .092 | .111 | .132 | .151 | .171 | .190 | .210 | .230 | .250 | .271 | 50 | 10 |
| 4 | 0 | 8 | 0 | 3.072 | 3.092 | 3.112 | 3.133 | 3.153 | 3.173 | 3.193 | 3.214 | 3.234 | 3.255 | 3.276 | 16 0 | 20 0 |
| | 10 | 7 | 50 | .072 | .093 | .113 | .135 | .155 | .176 | .196 | .217 | .238 | .260 | .281 | 10 | 19 50 |
| | 20 | | 40 | .072 | .093 | .114 | .136 | .157 | .178 | .199 | .220 | .242 | .264 | .285 | 20 | 40 |
| | 30 | | 30 | .072 | .094 | .115 | .137 | .159 | .180 | .202 | .223 | .245 | .268 | .289 | 30 | 30 |
| | 40 | | 20 | .072 | .094 | .116 | .138 | .160 | .182 | .204 | .226 | .248 | .271 | .293 | 40 | 20 |
| | 50 | | 10 | .072 | .095 | .117 | .139 | .161 | .184 | .206 | .229 | .251 | .274 | .296 | 50 | 10 |
| 5 | 0 | 7 | 0 | 3.072 | 3.095 | 3.117 | 3.140 | 3.162 | 3.185 | 3.207 | 3.231 | 3.253 | 3.277 | 3.299 | 17 0 | 19 0 |
| | 10 | 6 | 50 | .072 | .095 | .118 | .141 | .163 | .186 | .209 | .233 | .255 | .279 | .302 | 10 | 18 50 |
| | 20 | | 40 | .072 | .095 | .118 | .141 | .164 | .187 | .210 | .234 | .257 | .281 | .304 | 20 | 40 |
| | 30 | | 30 | .072 | .095 | .118 | .142 | .165 | .188 | .211 | .235 | .258 | .282 | .306 | 30 | 30 |
| | 40 | | 20 | .072 | .095 | .118 | .142 | .165 | .188 | .211 | .236 | .259 | .283 | .307 | 40 | 20 |
| | 50 | | 10 | .072 | .096 | .118 | .142 | .165 | .189 | .212 | .236 | .260 | .284 | .308 | 50 | 10 |
| 6 | 0 | 6 | 0 | 3.072 | 3.096 | 3.118 | 3.142 | 3.165 | 3.189 | 3.212 | 3.236 | 3.260 | 3.284 | 3.308 | 18 0 | 18 0 |

## TABLE OF PRECESSIONS IN R. A. FOR 1880.0. 0°.

| R. A. for + δ. | | 0° | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | R. A. for − δ. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| h. m. | h. m. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | h. m. | h. m. |
| 12 0 | 24 0 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 0 0 | 12 0 |
| 10 | 23 50 | .072 | .071 | .070 | .069 | .068 | .067 | .065 | .064 | .063 | .062 | .061 | 10 | 11 50 |
| 20 | 40 | .072 | .070 | .068 | .066 | .064 | .062 | .059 | .057 | .055 | .053 | .051 | 20 | 40 |
| 30 | 30 | .072 | .069 | .066 | .063 | .060 | .057 | .053 | .050 | .047 | .044 | .041 | 30 | 30 |
| 40 | 20 | .072 | .068 | .064 | .060 | .056 | .052 | .047 | .043 | .039 | .035 | .031 | 40 | 20 |
| 50 | 10 | .072 | .067 | .062 | .057 | .052 | .047 | .041 | .036 | .031 | .026 | .021 | 50 | 10 |
| 13 0 | 23 0 | 3.072 | 3.066 | 3.060 | 2.054 | 3.048 | 3.042 | 3.035 | 3.029 | 3.023 | 3.017 | 3.011 | 1 0 | 11 0 |
| 10 | 22 50 | .072 | .065 | .058 | .051 | .044 | .037 | .029 | .022 | .015 | .008 | 3.001 | 10 | 10 50 |
| 20 | 40 | .072 | .064 | .056 | .048 | .040 | .032 | .024 | .016 | .008 | 3.000 | 2.991 | 20 | 40 |
| 30 | 30 | .072 | .063 | .054 | .045 | .036 | .027 | .018 | .009 | 3.000 | 2.991 | .981 | 30 | 30 |
| 40 | 20 | .072 | .062 | .052 | .042 | .033 | .023 | .013 | 3.003 | 2.993 | .982 | .972 | 40 | 20 |
| 50 | 10 | .072 | .061 | .050 | .039 | .029 | .018 | .007 | 2.996 | .986 | .974 | .963 | 50 | 10 |
| 14 0 | 22 0 | 3.072 | 3.060 | 3.048 | 3.037 | 3.026 | 3.014 | 3.002 | 2.990 | 2.978 | 2.966 | 2.954 | 2 0 | 10 0 |
| 10 | 21 50 | .072 | .059 | .046 | .034 | .022 | .009 | 2.996 | .983 | .971 | .958 | .945 | 10 | 9 50 |
| 20 | 40 | .072 | .058 | .045 | .032 | .019 | .005 | .991 | .977 | .964 | .950 | .936 | 20 | 40 |
| 30 | 30 | .072 | .057 | .043 | .029 | .015 | 3.001 | .986 | .971 | .957 | .943 | .928 | 30 | 30 |
| 40 | 20 | .072 | .057 | .042 | .027 | .012 | 2.997 | .981 | .966 | .951 | .935 | .920 | 40 | 20 |
| 50 | 10 | .072 | .056 | .040 | .024 | .009 | .993 | .976 | .960 | .945 | .929 | .912 | 50 | 10 |
| 15 0 | 21 0 | 3.072 | 3.055 | 3.039 | 3.022 | 3.006 | 2.989 | 2.972 | 2.955 | 2.939 | 2.922 | 2.905 | 3 0 | 9 0 |
| 10 | 20 50 | .072 | .054 | .037 | .020 | .003 | .985 | .968 | .950 | .933 | .916 | .898 | 10 | 8 50 |
| 20 | 40 | .072 | .054 | .036 | .018 | 3.000 | .982 | .964 | .946 | .928 | .910 | .891 | 20 | 40 |
| 30 | 30 | .072 | .053 | .034 | .016 | 2.997 | .979 | .960 | .941 | .923 | .904 | .885 | 30 | 30 |
| 40 | 20 | .072 | .053 | .035 | .014 | .995 | .976 | .956 | .937 | .918 | .899 | .879 | 40 | 30 |
| 50 | 10 | .072 | .052 | .032 | .012 | .993 | .973 | .953 | .933 | .913 | .894 | .873 | 50 | 10 |
| 16 0 | 20 0 | 3.072 | 3.052 | 3.031 | 3.011 | 2.991 | 2.971 | 2.950 | 2.930 | 2.909 | 2.889 | 2.868 | 4 0 | 8 0 |
| 10 | 19 50 | .072 | .051 | .030 | .009 | .989 | .968 | .947 | .926 | .905 | .884 | .863 | 10 | 7 50 |
| 20 | 40 | .072 | .051 | .029 | .008 | .987 | .966 | .945 | .923 | .901 | .880 | .858 | 20 | 40 |
| 30 | 30 | .072 | .050 | .028 | .007 | .985 | .964 | .942 | .920 | .898 | .876 | .854 | 30 | 30 |
| 40 | 20 | .072 | .050 | .028 | .006 | .984 | .962 | .940 | .918 | .895 | .873 | .850 | 40 | 20 |
| 50 | 10 | .072 | .050 | .027 | .005 | .983 | .960 | .938 | .915 | .892 | .870 | .846 | 50 | 10 |
| 17 0 | 19 0 | 3.072 | 3.050 | 3.027 | 3.004 | 2.982 | 2.959 | 2.936 | 2.913 | 2.890 | 2.867 | 2.843 | 5 0 | 7 0 |
| 10 | 18 50 | .072 | .049 | .026 | .003 | .981 | .958 | .934 | .912 | .888 | .865 | .841 | 10 | 6 50 |
| 20 | 40 | .072 | .049 | .026 | .003 | .980 | .957 | .933 | .910 | .886 | .863 | .839 | 20 | 40 |
| 30 | 30 | .072 | .049 | .025 | .002 | .979 | .956 | .932 | .909 | .885 | .862 | .838 | 30 | 30 |
| 40 | 20 | .072 | .049 | .025 | .002 | .979 | .956 | .932 | .909 | .885 | .861 | .837 | 40 | 20 |
| 50 | 10 | .072 | .049 | .025 | .002 | .978 | .955 | .931 | .908 | .884 | .860 | .836 | 50 | 10 |
| 18 0 | 18 0 | 3.072 | 3.049 | 3.025 | 3.002 | 2.978 | 2.955 | 2.931 | 2.908 | 2.884 | 2.860 | 2.836 | 6 0 | 6 0 |

## 10.° TABLE OF PRECESSIONS IN R. A. FOR 1880.0

| R. A. for + δ. | | | | 10° | 11° | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 19° | 20° | R. A. for − δ. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| h. | m. | h. | m. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | h. m. | h. m. |
| 0 | 0 | 12 | 0 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 12 0 | 24 0 |
| | 10 | 11 | 50 | .083 | .084 | .085 | .086 | .087 | .088 | .089 | .090 | .091 | .092 | .094 | 10 | 23 50 |
| | 20 | | 40 | .093 | .095 | .097 | .099 | .101 | .103 | .105 | .108 | .110 | .112 | .115 | 20 | 40 |
| | 30 | | 30 | .103 | .106 | .109 | .113 | .116 | .119 | .122 | .126 | .129 | .132 | .136 | 30 | 30 |
| | 40 | | 20 | .113 | .117 | .121 | .126 | .130 | .134 | .138 | .143 | .147 | .152 | .157 | 40 | 20 |
| | 50 | | 10 | .123 | .128 | .133 | .139 | .144 | .150 | .155 | .161 | .166 | .172 | .178 | 50 | 10 |
| 1 | 0 | 11 | 0 | 3.133 | 3.139 | 3.145 | 3.152 | 3.158 | 3.165 | 3.171 | 3.178 | 3.184 | 3.191 | 3.198 | 13 0 | 23 0 |
| | 10 | 10 | 50 | .143 | .150 | .157 | .165 | .172 | .180 | .187 | .195 | .202 | .210 | .218 | 10 | 22 50 |
| | 20 | | 40 | .152 | .161 | .169 | .178 | .186 | .195 | .203 | .212 | .220 | .229 | .238 | 20 | 40 |
| | 30 | | 30 | .162 | .172 | .181 | .190 | .199 | .210 | .219 | .229 | .238 | .246 | .258 | 30 | 30 |
| | 40 | | 20 | .171 | .182 | .192 | .202 | .212 | .224 | .234 | .245 | .255 | .266 | .277 | 40 | 20 |
| | 50 | | 10 | .181 | .192 | .203 | .214 | .225 | .238 | .249 | .261 | .272 | .284 | .296 | 50 | 10 |
| 2 | 0 | 10 | 0 | 3.190 | 3.202 | 3.214 | 3.226 | 3.238 | 3.251 | 3.263 | 3.276 | 3.289 | 3.302 | 3.315 | 14 0 | 22 0 |
| | 10 | 9 | 50 | .199 | .212 | .225 | .238 | .251 | .264 | .277 | .291 | .305 | .319 | .333 | 10 | 21 50 |
| | 20 | | 40 | .207 | .221 | .235 | .249 | .263 | .277 | .291 | .306 | .321 | .336 | .351 | 20 | 40 |
| | 30 | | 30 | .215 | .230 | .245 | .260 | .275 | .290 | .305 | .321 | .336 | .352 | .368 | 30 | 20 |
| | 40 | | 20 | .223 | .239 | .254 | .270 | .286 | .302 | .318 | .335 | .351 | .368 | .385 | 40 | 30 |
| | 50 | | 10 | .231 | .248 | .263 | .280 | .297 | .314 | .330 | .348 | .365 | .383 | .401 | 50 | 10 |
| 3 | 0 | 9 | 0 | 3.238 | 3.256 | 3.272 | 3.290 | 3.307 | 3.325 | 3.342 | 3.361 | 3.379 | 3.398 | 3.416 | 15 0 | 21 0 |
| | 10 | 8 | 50 | .245 | .264 | .281 | .299 | .317 | .336 | .354 | .373 | .392 | .412 | .431 | 10 | 20 50 |
| | 20 | | 40 | .252 | .271 | .289 | .308 | .327 | .346 | .365 | .385 | .405 | .425 | .445 | 20 | 40 |
| | 30 | | 30 | .259 | .278 | .297 | .316 | .336 | .356 | .376 | .396 | .417 | .437 | .458 | 30 | 30 |
| | 40 | | 20 | .265 | .285 | .304 | .324 | .344 | .365 | .386 | .407 | .428 | .449 | .471 | 40 | 20 |
| | 50 | | 10 | .271 | .291 | .311 | .332 | .352 | .374 | .395 | .417 | .438 | .460 | .483 | 50 | 10 |
| 4 | 0 | 8 | 0 | 3.276 | 3.297 | 3.318 | 3.339 | 3.360 | 3.382 | 3.404 | 3.426 | 3.448 | 3.471 | 3.494 | 16 0 | 20 0 |
| | 10 | 7 | 50 | .281 | .302 | .324 | .346 | .367 | .390 | .412 | .434 | .457 | .481 | .504 | 10 | 19 50 |
| | 20 | | 40 | .285 | .307 | .329 | .352 | .374 | .397 | .419 | .442 | .465 | .490 | .514 | 20 | 40 |
| | 30 | | 30 | .289 | .312 | .334 | .357 | .380 | .403 | .426 | .449 | .473 | .498 | .522 | 30 | 30 |
| | 40 | | 20 | .293 | .316 | .339 | .362 | .385 | .409 | .432 | .456 | .480 | .505 | .530 | 40 | 20 |
| | 50 | | 10 | .296 | .320 | .343 | .366 | .390 | .414 | .437 | .462 | .486 | .511 | .536 | 50 | 10 |
| 5 | 0 | 7 | 0 | 3.299 | 3.323 | 3.347 | 3.370 | 3.394 | 3.418 | 3.442 | 3.467 | 3.492 | 3.517 | 3.542 | 17 0 | 19 0 |
| | 10 | 6 | 50 | .302 | .326 | .350 | .373 | .397 | .422 | .446 | .471 | .496 | .521 | .546 | 10 | 18 50 |
| | 20 | | 40 | .304 | .328 | .352 | .376 | .400 | .425 | .450 | .475 | .500 | .525 | .550 | 20 | 40 |
| | 30 | | 30 | .306 | .330 | .354 | .378 | .402 | .427 | .452 | .478 | .503 | .528 | .553 | 30 | 30 |
| | 40 | | 20 | .307 | .331 | .355 | .380 | .404 | .429 | .454 | .480 | .505 | .530 | .556 | 40 | 20 |
| | 50 | | 10 | .308 | .332 | .356 | .381 | .405 | .430 | .455 | .481 | .506 | .531 | .557 | 50 | 10 |
| 6 | 0 | 6 | 0 | 3.308 | 3.332 | 3.356 | 3.381 | 3.405 | 3.430 | 3.455 | 3.481 | 3.506 | 3.532 | 3.558 | 18 0 | 18 0 |

## TABLE OF PRECESSIONS IN R. A. FOR 1880.0. 10°.

| R. A. for + δ. | | 10° | 11° | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 19° | 20° | R. A. for − δ. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| h. m. | h. m | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | h. m. | h. m. |
| 12 0 | 24 0 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 0 0 | 12 0 |
| 10 | 23 50 | .061 | .060 | .059 | .058 | .057 | .056 | .055 | .054 | .053 | .052 | .051 | 10 | 11 50 |
| 20 | 40 | .051 | .049 | .047 | .045 | .043 | .041 | .038 | .036 | .034 | .032 | .030 | 20 | 40 |
| 30 | 30 | .041 | .038 | .034 | .031 | .028 | .025 | .021 | .018 | 3.015 | 3.012 | 3.009 | 30 | 30 |
| 40 | 20 | .031 | .027 | .022 | .018 | 3.014 | 3.010 | 3.005 | 3.001 | 2.996 | 2.993 | 2.988 | 40 | 20 |
| 50 | 10 | .021 | .016 | 3.009 | 3.004 | 2.999 | 2.994 | 2.988 | 2.983 | .977 | .972 | .967 | 50 | 10 |
| 13 0 | 23 0 | 3.011 | 3.005 | 2.997 | 2.991 | 2.985 | 2.979 | 2.972 | 2.966 | 2.959 | 2.953 | 2.946 | 1 0 | 11 0 |
| 10 | 22 50 | 3.001 | 2.994 | .985 | .978 | .971 | .964 | .956 | .949 | .941 | .934 | .926 | 10 | 10 50 |
| 20 | 40 | 2.991 | .983 | .974 | .966 | .957 | .949 | .940 | .932 | .923 | .915 | .906 | 20 | 40 |
| 30 | 30 | .981 | .972 | .963 | .953 | .943 | .934 | .924 | .915 | .905 | .896 | .886 | 30 | 30 |
| 40 | 20 | .972 | .962 | .952 | .941 | .930 | .920 | .909 | .899 | .888 | .877 | .867 | 40 | 20 |
| 50 | 10 | .963 | .952 | .941 | .929 | .917 | .906 | .894 | .883 | .871 | .859 | .848 | 50 | 10 |
| 14 0 | 22 0 | 2.954 | 2.942 | 2.930 | 2.918 | 2.905 | 2.893 | 2.880 | 2.868 | 2.855 | 2.842 | 2.829 | 2 0 | 10 0 |
| 10 | 21 50 | .945 | .932 | .919 | .906 | .893 | .880 | .865 | .852 | .838 | .825 | .811 | 10 | 9 50 |
| 20 | 40 | .936 | .923 | .909 | .895 | .881 | .867 | .851 | .837 | .822 | .808 | .793 | 20 | 40 |
| 30 | 30 | .928 | .914 | .899 | .884 | .869 | .854 | .838 | .823 | .807 | .792 | .776 | 30 | 30 |
| 40 | 20 | .920 | .905 | .889 | .874 | .858 | .842 | .825 | .809 | .792 | .776 | .759 | 40 | 20 |
| 50 | 10 | .912 | .896 | .880 | .864 | .847 | .830 | .812 | .796 | .778 | .761 | .743 | 50 | 10 |
| 15 0 | 21 0 | 2.905 | 2.888 | 2.871 | 2.854 | 2.837 | 2.819 | 2.800 | 2.783 | 2.764 | 2.746 | 2.728 | 3 0 | 9 0 |
| 10 | 20 50 | .898 | .880 | .862 | .845 | .827 | .809 | .789 | .771 | .751 | .732 | .713 | 10 | 8 50 |
| 20 | 40 | .891 | .873 | .854 | .836 | .817 | .798 | .778 | .759 | .739 | .719 | .699 | 20 | 40 |
| 30 | 30 | .885 | .866 | .846 | .827 | .808 | .788 | .768 | .748 | .727 | .706 | .686 | 30 | 30 |
| 40 | 20 | .879 | .859 | .839 | .819 | .799 | .779 | .758 | .737 | .715 | .694 | .673 | 40 | 20 |
| 50 | 10 | .873 | .853 | .832 | .812 | .791 | .770 | .749 | .727 | .705 | .683 | .661 | 50 | 10 |
| 16 0 | 20 0 | 2.868 | 2.847 | 2.826 | 2.805 | 2.783 | 2.762 | 2.740 | 2.718 | 2.695 | 2.673 | 2.650 | 4 0 | 8 0 |
| 10 | 19 50 | .863 | .841 | .820 | .798 | .776 | .754 | .732 | .709 | .685 | .663 | .640 | 10 | 7 50 |
| 20 | 40 | .858 | .836 | .814 | .792 | .769 | .747 | .724 | .702 | .677 | .654 | .630 | 20 | 40 |
| 30 | 30 | .854 | .832 | .809 | .787 | .763 | .741 | .717 | .695 | .670 | .646 | .621 | 30 | 30 |
| 40 | 20 | .850 | .828 | .805 | .782 | .758 | .735 | .711 | .688 | .663 | .639 | .614 | 40 | 20 |
| 50 | 10 | .846 | .824 | .801 | .778 | .753 | .730 | .706 | .682 | .657 | .633 | .607 | 50 | 10 |
| 17 0 | 19 0 | 2.843 | 2.821 | 2.797 | 2.774 | 2.749 | 2.726 | 2.701 | 2.677 | 2.652 | 2.628 | 2.602 | 5 0 | 7 0 |
| 10 | 18 50 | .841 | .818 | .794 | .771 | .746 | .722 | .697 | .673 | .648 | .623 | .598 | 10 | 6 50 |
| 20 | 40 | .839 | .816 | .792 | .768 | .743 | .719 | .694 | .669 | .644 | .619 | .594 | 20 | 40 |
| 30 | 30 | .838 | .814 | .790 | .766 | .741 | .717 | .692 | .666 | .641 | .617 | .590 | 30 | 30 |
| 40 | 20 | .837 | .813 | .789 | .764 | .739 | .715 | .690 | .664 | .639 | .615 | .588 | 40 | 20 |
| 50 | 10 | .836 | .812 | .788 | .763 | .738 | .714 | .689 | .663 | .638 | .613 | .587 | 50 | 10 |
| 18 0 | 18 0 | 2.836 | 2.812 | 2.787 | 2.763 | 2.738 | 2.714 | 2.688 | 2.663 | 2.637 | 2.612 | 2.586 | 6 0 | 6 0 |

## 20°. TABLE OF PRECESSIONS IN R. A. FOR 1880.0.

| R. A. for + δ. | | | | 20° | 21° | 22° | 23° | 24° | 25° | 26° | 27° | 28° | 29° | 30° | R. A. for − δ. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| h. | m. | h. | m. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | h. m. | h. m. |
| 0 | 0 | 12 | 0 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 12 0 | 24 0 |
| | 10 | 11 | 50 | .094 | .095 | .096 | .097 | .098 | .100 | .101 | .102 | .103 | .105 | .106 | 10 | 23 50 |
| | 20 | | 40 | .115 | .117 | .119 | .122 | .124 | .127 | .129 | .132 | .134 | .137 | .140 | 20 | 40 |
| | 30 | | 30 | .136 | .139 | .143 | .146 | .150 | .154 | .158 | .161 | .165 | .169 | .173 | 30 | 30 |
| | 40 | | 20 | .157 | .161 | .166 | .171 | .176 | .181 | .186 | .191 | .196 | .201 | .206 | 40 | 20 |
| | 50 | | 10 | .178 | .183 | .189 | .195 | .201 | .207 | .213 | .220 | .226 | .233 | .239 | 50 | 10 |
| 1 | 0 | 11 | 0 | 3.198 | 3.205 | 3.212 | 3.219 | 3.226 | 3.234 | 3.241 | 3.249 | 3.256 | 3.264 | 3.272 | 13 0 | 23 0 |
| | 10 | 10 | 50 | .218 | .227 | .235 | .243 | .251 | .260 | .268 | .277 | .286 | .295 | .304 | 10 | 22 50 |
| | 20 | | 40 | .238 | .248 | .257 | .266 | .276 | .286 | .295 | .305 | .315 | .326 | .336 | 20 | 40 |
| | 30 | | 30 | .258 | .269 | .279 | .289 | .300 | .311 | .322 | .333 | .344 | .356 | .368 | 30 | 30 |
| | 40 | | 20 | .277 | .289 | .301 | .312 | .324 | .336 | .348 | .360 | .373 | .386 | .399 | 40 | 20 |
| | 50 | | 10 | .296 | .309 | .322 | .334 | .347 | .360 | .373 | .387 | .401 | .415 | .429 | 50 | 10 |
| 2 | 0 | 10 | 0 | 3.315 | 3.329 | 3.342 | 3.356 | 3.370 | 3.384 | 3.398 | 3.413 | 3.428 | 3.443 | 3.458 | 14 0 | 22 0 |
| | 10 | 9 | 50 | .333 | .348 | .362 | .377 | .392 | .407 | .423 | .438 | .454 | .471 | .487 | 10 | 21 50 |
| | 20 | | 40 | .351 | .367 | .382 | .398 | .414 | .430 | .446 | .463 | .480 | .497 | .515 | 20 | 40 |
| | 30 | | 30 | .368 | .385 | .401 | .418 | .435 | .452 | .469 | .487 | .505 | .523 | .542 | 30 | 30 |
| | 40 | | 20 | .385 | .402 | .420 | .437 | .455 | .473 | .491 | .510 | .529 | .549 | .568 | 40 | 20 |
| | 50 | | 10 | .401 | .419 | .437 | .456 | .474 | .493 | .513 | .533 | .553 | .573 | .594 | 50 | 10 |
| 3 | 0 | 9 | 0 | 3.416 | 3.435 | 3.454 | 3.474 | 3.493 | 3.513 | 3.533 | 3.554 | 3.575 | 3.596 | 3.618 | 15 0 | 21 0 |
| | 10 | 8 | 50 | .431 | .451 | .471 | .491 | .511 | .532 | .553 | .575 | .596 | .619 | .641 | 10 | 20 50 |
| | 20 | | 40 | .445 | .465 | .486 | .507 | .528 | .550 | .572 | .594 | .617 | .640 | .664 | 20 | 40 |
| | 30 | | 30 | .458 | .479 | .501 | .523 | .545 | .567 | .590 | .613 | .636 | .660 | .685 | 30 | 30 |
| | 40 | | 20 | .471 | .493 | .515 | .537 | .560 | .583 | .606 | .630 | .655 | .679 | .705 | 40 | 20 |
| | 50 | | 10 | .483 | .505 | .528 | .551 | .574 | .598 | .622 | .647 | .672 | .697 | .723 | 50 | 10 |
| 4 | 0 | 8 | 0 | 3.494 | 3.517 | 3.540 | 3.564 | 3.588 | 3.612 | 3.637 | 3.662 | 3.688 | 3.714 | 3.741 | 16 0 | 20 0 |
| | 10 | 7 | 50 | .504 | .528 | .551 | .576 | .600 | .625 | .651 | .676 | .703 | .730 | .757 | 10 | 19 50 |
| | 20 | | 40 | .514 | .537 | .562 | .587 | .612 | .637 | .663 | .690 | .717 | .744 | .772 | 20 | 40 |
| | 30 | | 30 | .522 | .546 | .571 | .597 | .622 | .648 | .675 | .702 | .729 | .757 | .785 | 30 | 30 |
| | 40 | | 20 | .530 | .555 | .580 | .606 | .632 | .658 | .685 | .712 | .740 | .769 | .798 | 40 | 20 |
| | 50 | | 10 | .536 | .562 | .588 | .614 | .640 | .667 | .694 | .722 | .750 | .779 | .809 | 50 | 10 |
| 5 | 0 | 7 | 0 | 3.542 | 3.568 | 3.594 | 3.621 | 3.647 | 3.675 | 3.702 | 3.730 | 3.759 | 3.788 | 3.818 | 17 0 | 19 0 |
| | 10 | 6 | 50 | .546 | .573 | .600 | .626 | .653 | .681 | .709 | .737 | .766 | .796 | .826 | 10 | 18 50 |
| | 20 | | 40 | .550 | .578 | .604 | .631 | .658 | .686 | .715 | .743 | .772 | .802 | .832 | 20 | 40 |
| | 30 | | 30 | .553 | .581 | .608 | .635 | .662 | .690 | .719 | .748 | .777 | .807 | .838 | 30 | 30 |
| | 40 | | 20 | .556 | .584 | .610 | .638 | .665 | .693 | .722 | .751 | .780 | .811 | .841 | 40 | 20 |
| | 50 | | 10 | .557 | .585 | .612 | .639 | .667 | .695 | .724 | .753 | .783 | .813 | .843 | 50 | 10 |
| 6 | 0 | 6 | 0 | 3.558 | 3.586 | 3.613 | 3.640 | 3.668 | 3.696 | 3.724 | 3.754 | 3.783 | 3.813 | 3.844 | 18 0 | 18 0 |

## TABLE OF PRECESSIONS IN R. A. FOR 1880.0 **20°.**

| R. A. for + δ | | 20° | 21° | 22° | 23° | 24° | 25° | 26° | 27° | 28° | 29° | 30° | R. A. for − δ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| h. m. | h. m. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | h. m. | h. m. |
| 12 0 | 24 0 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 0 0 | 12 0 |
| 10 | 23 50 | .051 | .050 | .049 | .048 | .046 | .045 | .044 | .043 | .041 | .040 | .039 | 10 | 11 50 |
| 20 | 40 | .030 | .028 | .025 | 3.023 | 3.020 | 3.018 | 3.015 | 3.013 | 3.010 | 3.006 | 3.005 | 20 | 40 |
| 30 | 30 | 3.009 | 3.005 | 3.002 | 2.998 | 2.995 | 2.991 | 2.987 | 2.983 | 2.980 | 2.976 | 2.972 | 30 | 30 |
| 40 | 20 | 2.988 | 2.983 | 2.979 | .974 | .969 | .964 | .959 | .954 | .949 | .944 | .938 | 40 | 20 |
| 50 | 10 | .967 | .961 | .955 | .950 | .944 | .937 | .931 | .925 | .918 | .912 | .905 | 50 | 10 |
| 13 0 | 23 0 | 2.946 | 2.940 | 2.933 | 2.925 | 2.918 | 2.911 | 2.904 | 2.896 | 2.888 | 2.881 | 2.872 | 1 0 | 11 0 |
| 10 | 22 50 | .926 | .918 | .910 | .902 | .893 | .885 | .876 | .868 | .859 | .849 | .840 | 10 | 10 50 |
| 20 | 40 | .906 | .897 | .888 | .878 | .869 | .859 | .849 | .839 | .829 | .819 | .808 | 20 | 40 |
| 30 | 30 | .886 | .876 | .866 | .855 | .845 | .834 | .823 | .812 | .800 | .789 | .777 | 30 | 30 |
| 40 | 20 | .867 | .855 | .844 | .833 | .821 | .809 | .797 | .784 | .772 | .759 | .746 | 40 | 20 |
| 50 | 10 | .848 | .835 | .823 | .810 | .797 | .785 | .771 | .758 | .744 | .730 | .716 | 50 | 10 |
| 14 0 | 22 0 | 2.829 | 2.816 | 2.802 | 2.789 | 2.775 | 2.761 | 2.746 | 2.732 | 2.717 | 2.702 | 2.686 | 2 0 | 10 0 |
| 10 | 21 50 | .811 | .797 | .782 | .767 | .753 | .737 | .722 | .706 | .690 | .674 | .658 | 10 | 9 50 |
| 20 | 40 | .793 | .778 | .763 | .747 | .731 | .715 | .698 | .682 | .665 | .647 | .630 | 20 | 40 |
| 30 | 30 | .776 | .760 | .744 | .727 | .710 | .693 | .675 | .658 | .640 | .621 | .603 | 30 | 30 |
| 40 | 20 | .759 | .743 | .725 | .708 | .690 | .672 | .653 | .634 | .615 | .596 | .576 | 40 | 20 |
| 50 | 10 | .743 | .726 | .707 | .689 | .670 | .651 | .632 | .612 | .592 | .572 | .551 | 50 | 10 |
| 15 0 | 21 0 | 2.728 | 2.709 | 2.690 | 2.671 | 2.651 | 2.631 | 2.611 | 2.591 | 2.570 | 2.548 | 2.527 | 3 0 | 9 0 |
| 10 | 20 50 | .713 | .694 | .674 | .654 | .634 | .613 | .592 | .570 | .548 | .526 | .503 | 10 | 8 50 |
| 20 | 40 | .699 | .679 | .659 | .638 | .616 | .595 | .573 | .551 | .528 | .505 | .481 | 20 | 40 |
| 30 | 30 | .686 | .665 | .644 | .622 | .600 | .578 | .555 | .532 | .508 | .484 | .460 | 30 | 30 |
| 40 | 20 | .673 | .652 | .630 | .607 | .585 | .562 | .538 | .514 | .490 | .465 | .440 | 40 | 20 |
| 50 | 10 | .661 | .640 | .617 | .594 | .570 | .547 | .522 | .498 | .473 | .447 | .421 | 50 | 10 |
| 16 0 | 20 0 | 2.650 | 2.628 | 2.605 | 2.581 | 2.557 | 2.532 | 2.508 | 2.482 | 2.457 | 2.431 | 2.404 | 4 0 | 8 0 |
| 10 | 19 50 | .640 | .617 | .593 | .569 | .544 | .519 | .494 | .468 | .442 | .415 | .388 | 10 | 7 50 |
| 20 | 40 | .630 | .607 | .583 | .558 | .533 | .507 | .481 | .455 | .428 | .401 | .372 | 20 | 40 |
| 30 | 30 | .621 | .598 | .573 | .548 | .522 | .496 | .470 | .443 | .416 | .388 | .359 | 30 | 30 |
| 40 | 20 | .614 | .590 | .565 | .539 | .513 | .487 | .460 | .432 | .404 | .376 | .347 | 40 | 20 |
| 50 | 10 | .607 | .583 | .557 | .531 | .505 | .478 | .451 | .423 | .394 | .366 | .336 | 50 | 10 |
| 17 0 | 19 0 | 2.602 | 2.577 | 2.551 | 2.524 | 2.497 | 2.470 | 2.443 | 2.414 | 2.386 | 2.357 | 2.327 | 5 0 | 7 0 |
| 10 | 18 50 | .598 | .571 | .545 | .518 | .491 | .464 | .436 | .407 | .378 | .349 | .319 | 10 | 6 50 |
| 20 | 40 | .594 | .567 | .540 | .513 | .486 | .458 | .430 | .401 | .372 | .343 | .312 | 20 | 40 |
| 30 | 30 | .590 | .564 | .537 | .510 | .482 | .454 | .426 | .397 | .368 | .338 | .307 | 30 | 30 |
| 40 | 20 | .588 | .561 | .534 | .507 | .479 | .451 | .423 | .394 | .364 | .334 | .303 | 40 | 20 |
| 50 | 10 | .587 | .560 | .533 | .505 | .478 | .450 | .421 | .392 | .362 | .332 | .301 | 50 | 10 |
| 18 0 | 18 0 | 2.586 | 2.559 | 2.532 | 2.505 | 2.477 | 2.449 | 2.420 | 2.391 | 2.361 | 2.331 | 2.300 | 6 0 | 6 0 |

## 30°. TABLE OF PRECESSIONS IN R. A. FOR 1880.0.

| R. A. for + δ | | | | 30° | 31° | 32° | 33° | 34° | 35° | 36° | 37° | 38° | 39° | 40° | R. A. for — δ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| h. | m. | h. | m. | s. | s | s. | s. | s. | s. | s. | s. | s. | s. | s. | h. m. | h. m. |
| 0 | 0 | 12 | 0 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 12 0 | 24 0 |
| | 10 | 11 | 50 | .106 | .107 | .109 | .110 | .112 | .113 | .115 | .116 | .118 | .120 | .121 | 10 | 23 50 |
| | 20 | | 40 | .140 | .142 | .145 | .148 | .151 | .154 | .157 | .160 | .163 | .167 | .170 | 20 | 40 |
| | 30 | | 30 | .173 | .177 | .181 | .186 | .190 | .195 | .199 | .204 | .209 | .214 | .219 | 30 | 30 |
| | 40 | | 20 | .206 | .212 | .217 | .223 | .229 | .235 | .241 | .247 | .254 | .260 | .267 | 40 | 20 |
| | 50 | | 10 | .239 | .246 | .253 | .260 | .268 | .275 | .283 | .290 | .298 | .307 | .315 | 50 | 10 |
| 1 | 0 | 11 | 0 | 3.272 | 3.280 | 3.289 | 3.297 | 3.306 | 3.315 | 3.324 | 3.333 | 3.343 | 3.352 | 3.363 | 13 0 | 23 0 |
| | 10 | 10 | 50 | .304 | .314 | .324 | .333 | .343 | .354 | .364 | .375 | .386 | .398 | .410 | 10 | 22 50 |
| | 20 | | 40 | .336 | .347 | .358 | .369 | .381 | .393 | .405 | .417 | .430 | .443 | .456 | 20 | 40 |
| | 30 | | 30 | .368 | .380 | .392 | .405 | .417 | .431 | .444 | .458 | .472 | .487 | .502 | 30 | 30 |
| | 40 | | 20 | .399 | .412 | .425 | .439 | .453 | .468 | .483 | .498 | .514 | .530 | .549 | 40 | 20 |
| | 50 | | 10 | .429 | .443 | .458 | .473 | .489 | .505 | 521 | .538 | .555 | .572 | .590 | 50 | 10 |
| 2 | 0 | 10 | 0 | 3.458 | 3.474 | 3.490 | 3.506 | 3.523 | 3.540 | 3.558 | 3.576 | 3.595 | 3.614 | 3.633 | 14 0 | 22 0 |
| | 10 | 9 | 50 | .487 | .504 | .521 | .539 | .557 | .575 | .594 | .614 | .634 | .654 | .675 | 10 | 21 50 |
| | 20 | | 40 | .515 | .533 | .552 | .570 | .590 | .609 | .629 | .650 | .671 | .693 | .716 | 20 | 40 |
| | 30 | | 30 | .542 | .561 | .581 | .601 | .621 | .642 | .664 | .686 | .708 | .731 | .755 | 30 | 30 |
| | 40 | | 20 | .568 | .589 | .609 | .630 | .652 | .674 | .697 | .720 | .744 | .768 | .793 | 40 | 20 |
| | 50 | | 10 | .594 | .615 | .637 | .659 | .682 | .705 | .729 | .753 | .778 | .804 | .830 | 50 | 10 |
| 3 | 0 | 9 | 0 | 3.618 | 3.640 | 3.663 | 3.686 | 3.710 | 3.734 | 3.759 | 3.785 | 3.811 | 3.838 | 3.866 | 15 0 | 21 0 |
| | 10 | 8 | 50 | .641 | .665 | .688 | .712 | .737 | .762 | .788 | .815 | .842 | .870 | .899 | 10 | 20 50 |
| | 20 | | 40 | .664 | .688 | .712 | .737 | .763 | .789 | .816 | .844 | .872 | .902 | .932 | 20 | 40 |
| | 30 | | 30 | .685 | .710 | .735 | .761 | .788 | .815 | .843 | .872 | .901 | .931 | .962 | 30 | 30 |
| | 40 | | 20 | .705 | .730 | .757 | .784 | .811 | .839 | .868 | .898 | .928 | .959 | 3.991 | 40 | 20 |
| | 50 | | 10 | .723 | .750 | .777 | .805 | .833 | .862 | .892 | .922 | .953 | 3.985 | 4.018 | 50 | 10 |
| 4 | 0 | 8 | 0 | 3.741 | 3.768 | 3.796 | 3.824 | 3.853 | 3.883 | 3.914 | 3.945 | 3.977 | 4.010 | 4.044 | 16 0 | 20 0 |
| | 10 | 7 | 50 | .757 | .785 | .813 | .842 | .872 | .903 | .934 | .966 | 3.999 | .033 | .067 | 10 | 19 50 |
| | 20 | | 40 | .772 | .800 | .829 | .859 | .890 | .921 | .953 | 3.985 | 4.019 | .053 | .089 | 20 | 40 |
| | 30 | | 30 | .785 | .814 | .844 | .875 | .905 | .937 | .970 | 4.003 | .037 | .073 | .109 | 30 | 30 |
| | 40 | | 20 | .796 | .827 | .857 | .888 | .920 | .952 | .985 | .019 | .054 | .090 | .126 | 40 | 20 |
| | 50 | | 10 | .809 | .838 | .869 | .900 | .932 | .965 | 3.999 | .033 | .068 | .105 | .142 | 50 | 10 |
| 5 | 0 | 7 | 0 | 3.818 | 3.848 | 3.879 | 3.911 | 3.943 | 3.977 | 4.011 | 4.045 | 4.081 | 4.118 | 4.156 | 17 0 | 19 0 |
| | 10 | 6 | 50 | .826 | .857 | .888 | .920 | .953 | .986 | .021 | .056 | .092 | .129 | .168 | 10 | 18 50 |
| | 20 | | 40 | .832 | .863 | .895 | .927 | .960 | 3.994 | .029 | .065 | .101 | .139 | .177 | 20 | 40 |
| | 30 | | 30 | .838 | .869 | .901 | .933 | .966 | 4.000 | .035 | .071 | .108 | '146 | .185 | 30 | 30 |
| | 40 | | 20 | .841 | .873 | .905 | .937 | .971 | .005 | .040 | .076 | .113 | .151 | .190 | 40 | 20 |
| | 50 | | 10 | .843 | .875 | .907 | .940 | .973 | .007 | .043 | .079 | .116 | .154 | .193 | 50 | 10 |
| 6 | 0 | 6 | 0 | 3.844 | 3.876 | 3.908 | 3.941 | 3.974 | 4.008 | 4.044 | 4.080 | 4.117 | 4.155 | 4.194 | 18 0 | 18 0 |

## TABLE OF PRECESSIONS IN R. A. FOR 1880.0. 30°

| R. A. for + δ | | 30° | 31° | 32° | 33° | 34° | 35° | 36° | 37° | 38° | 39° | 40° | R. A. for + δ. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| h. m. | h. m. | s | s | s | s | s | s | s | s | s | s | s | h. m. | h. m. |
| 12 0 | 24 0 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 0 0 | 12 0 |
| 10 | 23 50 | .039 | .037 | .036 | 3.034 | 3.035 | 3.032 | 3.030 | 3.028 | 3.027 | 3.025 | 3.023 | 10 | 11 50 |
| 20 | 40 | 3.005 | 3.002 | 3.000 | 2.997 | 2.994 | 2.991 | 2.988 | 2.985 | 2.981 | 2.978 | 2.975 | 20 | 40 |
| 30 | 30 | 2.972 | 2.968 | 2.963 | .959 | .955 | .950 | .946 | .941 | .936 | .931 | .926 | 30 | 30 |
| 40 | 20 | .938 | .933 | .927 | .922 | .916 | .910 | .904 | .897 | .891 | .884 | .878 | 40 | 20 |
| 50 | 10 | .905 | .896 | .892 | .884 | 877 | .870 | .862 | .854 | .846 | .838 | .830 | 50 | 10 |
| 13 0 | 23 0 | 2.872 | 2.864 | 2.856 | 2.848 | 2.839 | 2.830 | 2.821 | 2.812 | 2.802 | 2.792 | 2.782 | 1 0 | 11 0 |
| 10 | 22 50 | .840 | .831 | .821 | .811 | .801 | .791 | .780 | .769 | .758 | .747 | .735 | 10 | 10 50 |
| 20 | 40 | .808 | .798 | .787 | .775 | .764 | .752 | .740 | .728 | .715 | .702 | .689 | 20 | 40 |
| 30 | 30 | .777 | .765 | .753 | .740 | .727 | .714 | .701 | .687 | .673 | .658 | .643 | 30 | 30 |
| 40 | 20 | .746 | .733 | .719 | .705 | .691 | .677 | .662 | .647 | .631 | .615 | .598 | 40 | 20 |
| 50 | 10 | .716 | .701 | .687 | .671 | .656 | .640 | .624 | .607 | .590 | .573 | .554 | 50 | 10 |
| 14 0 | 22 0 | 2.686 | 2.671 | 2.655 | 2.638 | 2.621 | 2.604 | 2.587 | 2.569 | 2.550 | 2.531 | 2.511 | 2 0 | 10 0 |
| 10 | 21 50 | .658 | .641 | .623 | .606 | .588 | .569 | .550 | .531 | .511 | .491 | .470 | 10 | 9 50 |
| 20 | 40 | .630 | .612 | .593 | .574 | .555 | .535 | .515 | .495 | .473 | .451 | .429 | 20 | 40 |
| 30 | 30 | .603 | .583 | .564 | .544 | .523 | .503 | .481 | .459 | .436 | .413 | .389 | 30 | 30 |
| 40 | 20 | .576 | .556 | .535 | .514 | .493 | .471 | .448 | .425 | .401 | .377 | .351 | 40 | 20 |
| 50 | 10 | .551 | .530 | .508 | .486 | .463 | .440 | .416 | .392 | .367 | .341 | .314 | 50 | 10 |
| 15 0 | 21 0 | 2.527 | 2.504 | 2.482 | 2.458 | 2.435 | 2.410 | 2.386 | 2.360 | 2.334 | 2.307 | 2.279 | 3 0 | 9 0 |
| 10 | 20 50 | .503 | .480 | .456 | .432 | .408 | .382 | .356 | .330 | .302 | .274 | .245 | 10 | 8 50 |
| 20 | 40 | .481 | .457 | .432 | .407 | .382 | .355 | .328 | .301 | .272 | .243 | .213 | 20 | 40 |
| 30 | 30 | .460 | .435 | .410 | .384 | .357 | .329 | .302 | .273 | .244 | .214 | .182 | 30 | 30 |
| 40 | 20 | .440 | .414 | .388 | .361 | .334 | .305 | .277 | .247 | .217 | .186 | .153 | 40 | 20 |
| 50 | 10 | .421 | .395 | .368 | .340 | .312 | .283 | .253 | .223 | .191 | .159 | .126 | 50 | 10 |
| 16 0 | 20 0 | 2.404 | 2.377 | 2.349 | 2.320 | 2.291 | 2.262 | 2.231 | 2.200 | 2.168 | 2.135 | 2.101 | 4 0 | 8 0 |
| 10 | 19 50 | .388 | .360 | .331 | .302 | .272 | .242 | .211 | .179 | .146 | .112 | .077 | 10 | 7 50 |
| 20 | 40 | .372 | .344 | .315 | .285 | .255 | .224 | .192 | .159 | .126 | .091 | .056 | 20 | 40 |
| 30 | 30 | .359 | .330 | .301 | .270 | .239 | .208 | .175 | .142 | .107 | .072 | .036 | 30 | 30 |
| 40 | 20 | .347 | .318 | .287 | .256 | .225 | .193 | .160 | .126 | .091 | .055 | .018 | 40 | 20 |
| 50 | 10 | .336 | .306 | .276 | .244 | .212 | .180 | .146 | .112 | .076 | .040 | 2.002 | 50 | 10 |
| 17 0 | 19 0 | 2.327 | 2.296 | 2.265 | 2.234 | 2.201 | 2.168 | 2.134 | 2.099 | 2.063 | 2.027 | 1.989 | 5 0 | 7 0 |
| 10 | 18 50 | .319 | .288 | .257 | .225 | .192 | .158 | .124 | .089 | .053 | .015 | .977 | 10 | 6 50 |
| 20 | 40 | .312 | .281 | .250 | .217 | .184 | .150 | .116 | .080 | .044 | 2.006 | .968 | 20 | 40 |
| 30 | 30 | .307 | .276 | .244 | .212 | .178 | .144 | .109 | .073 | .037 | 1.999 | .960 | 30 | 30 |
| 40 | 20 | .303 | .272 | .240 | .208 | .174 | .140 | .105 | .069 | .032 | .994 | .955 | 40 | 20 |
| 50 | 10 | .301 | .270 | .238 | .205 | .171 | .137 | .102 | .066 | .029 | .991 | .952 | 50 | 10 |
| 18 0 | 18 0 | 2.300 | 2.269 | 2.237 | 2.204 | 2.171 | 2.136 | 2.101 | 2.065 | 2.028 | 1.990 | 1.951 | 6 0 | 6 0 |

## 40° TABLE OF PRECESSIONS IN R. A. FOR 1880.0

| R. A. for + δ | | 40° | 41° | 42° | 43° | 44° | 45° | 46° | 47° | 48° | 49° | 50° | R. A. for − δ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| h. m. | h. m. | s | s | s | s | s | s | s | s | s | s | s | h. m. | h. m. |
| 0 0 | 12 0 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 12 0 | 24 0 |
| 10 | 11 50 | .121 | .123 | .125 | .127 | .129 | .131 | .133 | .135 | .137 | .139 | .142 | 10 | 23 50 |
| 20 | 40 | .170 | .174 | .177 | .181 | .185 | .189 | .193 | .197 | .202 | .206 | .211 | 20 | 40 |
| 30 | 30 | .219 | .224 | .230 | .235 | .241 | .247 | .253 | .259 | .266 | .273 | .280 | 30 | 30 |
| 40 | 20 | .267 | .274 | .281 | .289 | .297 | .305 | .313 | .321 | .330 | .339 | .349 | 40 | 20 |
| 50 | 10 | .315 | .324 | .333 | .342 | .354 | .362 | .372 | .383 | .394 | .405 | .417 | 50 | 10 |
| 1 0 | 11 0 | 3.363 | 3.373 | 3.384 | 3.395 | 3.407 | 3.418 | 3.431 | 3.443 | 3.457 | 3.470 | 3.485 | 13 0 | 23 0 |
| 10 | 10 50 | .410 | .422 | .434 | .447 | .461 | .474 | .489 | .503 | .519 | .535 | .551 | 10 | 22 50 |
| 20 | 40 | .456 | .471 | .484 | .499 | .514 | .530 | .546 | .563 | .580 | .598 | .617 | 20 | 40 |
| 30 | 30 | .502 | .517 | .533 | .549 | .566 | .584 | .602 | .621 | .641 | .661 | .682 | 30 | 30 |
| 40 | 20 | .546 | .564 | .581 | .599 | .618 | .637 | .657 | .678 | .700 | .722 | .746 | 40 | 20 |
| 50 | 10 | .590 | .606 | .628 | .648 | .669 | .690 | 712 | .734 | .758 | .783 | .808 | 50 | 10 |
| 2 0 | 10 0 | 3.633 | 3.653 | 3.674 | 3.696 | 3.718 | 3.741 | 3.765 | 3.789 | 3.815 | 3.841 | 3.869 | 14 0 | 22 0 |
| 10 | 9 50 | .675 | .697 | .719 | .742 | .766 | .791 | .816 | .843 | .870 | .899 | .928 | 10 | 21 50 |
| 20 | 40 | .716 | .739 | .763 | .787 | .813 | .849 | .866 | .895 | .924 | 3.954 | 3.986 | 20 | 40 |
| 30 | 30 | .755 | .780 | .805 | .831 | .858 | .886 | .915 | .945 | 3.976 | 4.009 | 4.042 | 30 | 30 |
| 40 | 20 | .793 | .819 | .846 | .874 | .902 | .932 | 3.962 | 3.994 | 4.027 | .061 | .096 | 40 | 20 |
| 50 | 10 | .830 | .857 | .885 | .914 | .944 | 3.976 | 4.008 | 4.041 | .076 | .111 | .149 | 50 | 10 |
| 3 0 | 9 0 | 3.866 | 3.894 | 3.924 | 3.954 | 3.985 | 4.018 | 4.051 | 4.086 | 4.122 | 4.160 | 4.199 | 15 0 | 21 0 |
| 10 | 8 50 | .899 | .929 | .960 | 3.992 | 4.024 | .058 | .093 | .129 | .167 | .206 | .247 | 10 | 20 50 |
| 20 | 40 | 932 | .963 | 3.994 | 4.027 | .061 | .096 | .133 | .171 | .210 | .250 | .293 | 20 | 40 |
| 30 | 30 | .962 | 3.994 | 4.027 | .061 | .097 | .133 | .171 | .210 | .250 | .292 | .336 | 30 | 30 |
| 40 | 20 | 3.991 | 4.024 | .058 | .094 | .130 | .167 | .206 | .247 | .289 | .332 | .378 | 40 | 20 |
| 50 | 10 | 4.018 | .053 | .088 | .124 | .161 | .200 | .240 | .281 | .325 | .369 | .416 | 50 | 10 |
| 4 0 | 8 0 | 4.044 | 4.079 | 4.115 | 4.152 | 4.190 | 4.230 | 4.271 | 4.314 | 4.358 | 4.404 | 4.452 | 16 0 | 20 0 |
| 10 | 7 50 | .067 | .103 | .140 | .178 | .217 | .258 | .300 | .344 | .389 | .437 | .486 | 10 | 19 50 |
| 20 | 40 | .089 | .126 | .163 | .202 | .242 | .284 | .327 | .372 | .418 | .466 | .516 | 20 | 40 |
| 30 | 30 | .109 | .146 | .184 | .224 | .265 | .307 | .351 | .397 | .444 | .493 | .544 | 30 | 30 |
| 40 | 20 | .126 | .164 | .203 | .244 | .286 | .329 | .373 | .419 | .468 | .518 | .570 | 40 | 20 |
| 50 | 10 | .142 | .181 | .220 | .261 | .304 | .347 | .393 | .440 | .489 | .539 | .592 | 50 | 10 |
| 5 0 | 7 0 | 4.156 | 4.195 | 4.235 | 4.277 | 4.319 | 4.364 | 4.410 | 4.457 | 4.507 | 4.558 | 4.611 | 17 0 | 19 0 |
| 10 | 6 50 | .168 | .207 | .248 | .290 | .333 | .378 | .424 | .472 | .522 | .574 | .628 | 10 | 18 50 |
| 20 | 40 | .177 | .217 | .258 | .301 | .344 | .389 | .436 | .484 | .535 | .587 | .641 | 20 | 40 |
| 30 | 30 | .185 | .225 | .266 | .308 | .352 | .398 | .445 | .494 | .544 | .597 | .652 | 30 | 30 |
| 40 | 20 | .190 | .230 | .272 | .314 | .359 | .404 | .452 | .501 | .552 | .604 | .660 | 40 | 20 |
| 50 | 10 | .193 | .233 | .275 | .318 | .362 | .408 | .455 | .505 | .556 | .609 | .664 | 50 | 10 |
| 6 0 | 6 0 | 4.194 | 4.234 | 4.276 | 4.319 | 4.363 | 4.409 | 4.457 | 4.506 | 4.557 | 4.610 | 4.666 | 18 0 | 18 0 |

## TABLE OF PRECESSIONS IN R. A. FOR 1880.0. 40°.

| R. A. for + δ. | | 40° | 41° | 42° | 43° | 44° | 45° | 46° | 47° | 48° | 49° | 50° | R. A. for — δ. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| h. m. | h. m. | s | s | s | s | s | s | s | s | s | s | s | h. m. | h. m. |
| 12 0 | 24 0 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 0 0 | 12 0 |
| 10 | 23 50 | 3.023 | 3.022 | 3.020 | 3.018 | 3.016 | 3.014 | 3.012 | 3.010 | 3.008 | 3.005 | 3.003 | 10 | 11 50 |
| 20 | 40 | 2.975 | 2.971 | 2.967 | 2.964 | 2.960 | 2.956 | 2.952 | 2.947 | 2.943 | 2.938 | 2.933 | 20 | 40 |
| 30 | 30 | .926 | .921 | .915 | .910 | .904 | .898 | .892 | .885 | .878 | .872 | .864 | 30 | 30 |
| 40 | 20 | .878 | .871 | .863 | .856 | .848 | .840 | .832 | .823 | .814 | .805 | .796 | 40 | 20 |
| 50 | 10 | .830 | .821 | .812 | .803 | .793 | .783 | .773 | .762 | .751 | .739 | .727 | 50 | 10 |
| 13 0 | 23 0 | 2.782 | 2.772 | 2.761 | 2.750 | 2.738 | 2.726 | 2.714 | 2.701 | 2.688 | 2.674 | 2.660 | 1 0 | 11 0 |
| 10 | 22 50 | .735 | .723 | .710 | .697 | .684 | .670 | .656 | .641 | .626 | .610 | .593 | 10 | 10 50 |
| 20 | 40 | .689 | .675 | .661 | .646 | .631 | .615 | .599 | .582 | .565 | .546 | .527 | 20 | 40 |
| 30 | 30 | .643 | .628 | .612 | .595 | .578 | .561 | .543 | .524 | .504 | .484 | .463 | 30 | 30 |
| 40 | 20 | .598 | .581 | .564 | .545 | .527 | .507 | .487 | .466 | .445 | .422 | .399 | 40 | 20 |
| 50 | 10 | .554 | .536 | .516 | .497 | .476 | .455 | .433 | .410 | .387 | .362 | .337 | 50 | 10 |
| 14 0 | 22 0 | 2.511 | 2.491 | 2.470 | 2.449 | 2.427 | 2.404 | 2.380 | 2.356 | 2.330 | 2.303 | 2.276 | 2 0 | 10 0 |
| 10 | 21 50 | .470 | .448 | .426 | .403 | .379 | .354 | .329 | .302 | .274 | .246 | .216 | 10 | 9 50 |
| 20 | 40 | .429 | .406 | .382 | .357 | .332 | .305 | .278 | .250 | .221 | .190 | .158 | 20 | 40 |
| 30 | 30 | .389 | .365 | .340 | .313 | .286 | .258 | .230 | .200 | .168 | .136 | .102 | 30 | 30 |
| 40 | 20 | .351 | .325 | .299 | .271 | .242 | .213 | .182 | .151 | .118 | .084 | 2.048 | 40 | 20 |
| 50 | 10 | .314 | .287 | .259 | .230 | .200 | .169 | .137 | .104 | .069 | 2.033 | 1.996 | 50 | 10 |
| 15 0 | 21 0 | 2.279 | 2.251 | 2.221 | 2.191 | 2.159 | 2.127 | 2.093 | 2.059 | 2.023 | 1.985 | 1.946 | 3 0 | 9 0 |
| 10 | 20 50 | .245 | .215 | .185 | .153 | .120 | .087 | .052 | 2.015 | 1.978 | .938 | .898 | 10 | 8 50 |
| 20 | 40 | .213 | .182 | .150 | .117 | .083 | .048 | 2.012 | 1.974 | .935 | .894 | .852 | 20 | 40 |
| 30 | 30 | .182 | .150 | .117 | .083 | .048 | 2.012 | 1.974 | .935 | .894 | .852 | .808 | 30 | 30 |
| 40 | 20 | .153 | .120 | .086 | .051 | 2.015 | 1.977 | .938 | .898 | .856 | .813 | .767 | 40 | 20 |
| 50 | 10 | .126 | .092 | .057 | 2.021 | 1.983 | .945 | .905 | .863 | .820 | .775 | .729 | 50 | 10 |
| 16 0 | 20 0 | 2.101 | 2.066 | 2.030 | 1.993 | 1.954 | 1.914 | 1.873 | 1.831 | 1.786 | 1.740 | 1.693 | 4 0 | 8 0 |
| 10 | 19 50 | .077 | .041 | 2.005 | .966 | .927 | .886 | .844 | .801 | .755 | .708 | .659 | 10 | 7 50 |
| 20 | 40 | .056 | 2.019 | 1.981 | .942 | .902 | .861 | .818 | .773 | .727 | .678 | .628 | 20 | 40 |
| 30 | 30 | .036 | 1.999 | .960 | .921 | .880 | .837 | .793 | .748 | .701 | .651 | .600 | 30 | 30 |
| 40 | 20 | .018 | .980 | .941 | .901 | .859 | .816 | .771 | .725 | .677 | .627 | .575 | 40 | 20 |
| 50 | 10 | 2.002 | .964 | .924 | .883 | .841 | .797 | .752 | .705 | .656 | .606 | .553 | 50 | 10 |
| 17 0 | 19 0 | 1.989 | 1.950 | 1.910 | 1.868 | 1.825 | 1.781 | 1.735 | 1.687 | 1.638 | 1.587 | 1.533 | 5 0 | 7 0 |
| 10 | 18 50 | .977 | .938 | .897 | .855 | .812 | .767 | .721 | .673 | .623 | .571 | .517 | 10 | 6 50 |
| 20 | 40 | .968 | .928 | .887 | .845 | .801 | .756 | .709 | .660 | .610 | .558 | .503 | 20 | 40 |
| 30 | 30 | .960 | .920 | .879 | .836 | .792 | .747 | .700 | .651 | .600 | .548 | .493 | 30 | 30 |
| 40 | 20 | .955 | .915 | .873 | .830 | .786 | .740 | .693 | .644 | .593 | .540 | .485 | 40 | 20 |
| 50 | 10 | .952 | .911 | .870 | .827 | .783 | .737 | .689 | .640 | .589 | .536 | .481 | 50 | 10 |
| 18 0 | 18 0 | 1.951 | 1.910 | 1.869 | 1.826 | 1.781 | 1.735 | 1.688 | 1.639 | 1.587 | 1.534 | 1.479 | 6 0 | 6 0 |

## 50°. TABLE OF PRECESSIONS IN R. A. FOR 1880.0.

| R. A. for + δ. | | | | 50° | 51° | 52° | 53° | 54° | 55° | 56° | 57° | 58° | 59° | 60° | R. A. for − δ. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| h. | m. | h. | m. | s | s | s | s | s | s | s | s | s | s | s | h. | m. | h. | m. |
| 0 | 0 | 12 | 0 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 12 | 0 | 24 | 0 |
| | 10 | 11 | 50 | .142 | .144 | .147 | .150 | .153 | .156 | .159 | .162 | .166 | .169 | .173 | | 10 | 23 | 50 |
| | 20 | | 40 | .211 | .216 | .221 | .227 | .233 | .239 | .245 | .252 | .259 | .266 | .274 | | 20 | | 40 |
| | 30 | | 30 | .280 | .288 | .296 | .304 | .313 | .322 | .331 | .341 | .352 | .363 | .375 | | 30 | | 30 |
| | 40 | | 20 | .349 | .359 | .369 | .380 | .392 | .404 | .417 | .430 | .444 | .459 | .474 | | 40 | | 20 |
| | 50 | | 10 | .417 | .430 | .443 | .456 | .471 | .486 | .501 | .518 | .535 | .554 | .574 | | 50 | | 10 |
| 1 | 0 | 11 | 0 | 3.485 | 3.500 | 3.515 | 3.532 | 3.549 | 3.567 | 3.585 | 3.605 | 3.626 | 3.648 | 3.672 | 13 | 0 | 23 | 0 |
| | 10 | 10 | 50 | .551 | .569 | .587 | .606 | .626 | .646 | .668 | .691 | .716 | .741 | .769 | | 10 | 22 | 50 |
| | 20 | | 40 | .617 | .637 | .658 | .679 | .702 | .725 | .750 | .777 | .804 | .833 | .864 | | 20 | | 40 |
| | 30 | | 30 | .682 | .704 | .727 | .751 | .777 | .803 | .831 | .860 | .891 | 3.924 | 3.959 | | 30 | | 30 |
| | 40 | | 20 | .746 | .770 | .796 | .822 | .850 | .879 | .910 | 3.942 | 3.977 | 4.013 | 4.051 | | 40 | | 20 |
| | 50 | | 10 | .808 | .835 | .862 | .892 | .922 | 3.954 | 3.988 | 4.023 | 4.060 | .100 | .142 | | 50 | | 10 |
| 2 | 0 | 10 | 0 | 3.869 | 3.898 | 3.928 | 3.959 | 3.992 | 4.027 | 4.063 | 4.102 | 4.142 | 4.185 | 4.230 | 14 | 0 | 22 | 0 |
| | 10 | 9 | 50 | .928 | 3.959 | 3.992 | 4.026 | 4.061 | .098 | .137 | .178 | .222 | .268 | .317 | | 10 | 21 | 50 |
| | 20 | | 40 | 3.986 | 4.019 | 4.054 | .090 | .128 | .167 | .209 | .253 | .300 | .349 | .401 | | 20 | | 40 |
| | 30 | | 30 | 4.042 | .077 | .114 | .152 | .193 | .235 | .279 | .326 | .375 | .427 | .482 | | 30 | | 30 |
| | 40 | | 20 | .096 | .134 | .172 | .213 | .255 | .300 | .346 | .396 | .448 | .503 | .561 | | 40 | | 20 |
| | 50 | | 10 | .149 | .188 | .228 | .271 | .316 | .362 | .411 | .463 | .518 | .576 | .637 | | 50 | | 10 |
| 3 | 0 | 9 | 0 | 4.199 | 4.240 | 4.282 | 4.327 | 4.374 | 4.422 | 4.474 | 4.528 | 4.585 | 4.646 | 4.710 | 15 | 0 | 21 | 0 |
| | 10 | 8 | 50 | .247 | .290 | .334 | .380 | .429 | .480 | .534 | .590 | .650 | .713 | .780 | | 10 | 20 | 50 |
| | 20 | | 40 | .293 | .337 | .383 | .431 | .482 | .535 | .591 | .649 | .711 | .777 | .846 | | 20 | | 40 |
| | 30 | | 30 | .336 | .382 | .430 | .480 | .532 | .587 | .645 | .706 | .770 | .838 | .909 | | 30 | | 30 |
| | 40 | | 20 | .378 | .425 | .474 | .527 | .580 | .636 | .696 | .759 | .825 | .895 | 4.969 | | 40 | | 20 |
| | 50 | | 10 | .416 | .465 | .516 | .569 | .624 | .683 | .744 | .809 | .877 | .949 | 5.025 | | 50 | | 10 |
| 4 | 0 | 8 | 0 | 4.452 | 4.502 | 4.554 | 4.609 | 4.666 | 4.726 | 4.789 | 4.855 | 4.925 | 4.999 | 5.078 | 16 | 0 | 20 | 0 |
| | 10 | 7 | 50 | .486 | .537 | .590 | .646 | .705 | .766 | .830 | .898 | 4.970 | 5.046 | .126 | | 10 | 19 | 50 |
| | 20 | | 40 | .516 | .569 | .623 | .680 | .740 | .803 | .869 | .938 | 5.011 | .089 | .171 | | 20 | | 40 |
| | 30 | | 30 | .544 | .598 | .653 | .711 | .772 | .836 | .904 | 4.974 | .049 | .128 | .212 | | 30 | | 30 |
| | 40 | | 20 | .570 | .624 | .680 | .740 | .802 | .867 | .935 | 5.007 | .083 | .163 | .248 | | 40 | | 20 |
| | 50 | | 10 | .592 | .647 | .704 | .764 | .827 | .893 | .963 | .035 | .113 | .194 | .281 | | 50 | | 10 |
| 5 | 0 | 7 | 0 | 4.611 | 4.667 | 4.725 | 4.786 | 4.850 | 4.917 | 4.987 | 5.061 | 5.139 | 5.222 | 5.309 | 17 | 0 | 19 | 0 |
| | 10 | 6 | 50 | .628 | .684 | .743 | .804 | .869 | .936 | 5.007 | .082 | .161 | .245 | .333 | | 10 | 18 | 50 |
| | 20 | | 40 | .641 | .698 | .758 | .820 | .885 | .953 | .024 | .100 | .179 | .264 | .353 | | 20 | | 40 |
| | 30 | | 30 | .652 | .709 | .769 | .831 | .897 | .965 | .037 | .113 | .194 | .278 | .368 | | 30 | | 30 |
| | 40 | | 20 | .660 | .717 | .777 | .840 | .905 | .974 | .047 | .123 | .204 | .289 | .379 | | 40 | | 20 |
| | 50 | | 10 | .664 | .722 | .782 | .845 | .911 | .980 | .053 | .129 | .210 | .295 | .386 | | 50 | | 10 |
| 6 | 0 | 6 | 0 | 4.666 | 4.723 | 4.784 | 4.847 | 4.912 | 4.982 | 5.054 | 5.131 | 5.212 | 5.297 | 5.388 | 18 | 0 | 18 | 0 |

## TABLE OF PRECESSIONS IN R. A. 1880.0. 50°.

| R. A. for $+\delta$ | | | | 50° | 51° | 52° | 53° | 54° | 55° | 56° | 57° | 58° | 59° | 60° | R. A. for $-\delta$. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| h. | m. | h. | m. | s | s | s | s | s | s | s | s | s | s | s | h. m. | h. m. |
| 12 | 0 | 24 | 0 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 3.072 | 0 0 | 12 0 |
| | 10 | 23 | 50 | 3.003 | 3.000 | 2.998 | 2.995 | 2.992 | 2.989 | 2.986 | 2.983 | 2.979 | 2.975 | 2.971 | 10 | 11 50 |
| | 20 | | 40 | 2.933 | 2.928 | .923 | .918 | .912 | .906 | .899 | .893 | .886 | .878 | .871 | 20 | 40 |
| | 30 | | 30 | .864 | .857 | .849 | .841 | .832 | .823 | .814 | .804 | .794 | .782 | .770 | 30 | 30 |
| | 40 | | 20 | .796 | .786 | .775 | .764 | .753 | .741 | .728 | .715 | .701 | .686 | .670 | 40 | 20 |
| | 50 | | 10 | .727 | .715 | .702 | .688 | .674 | .659 | .643 | .627 | .609 | .591 | .571 | 50 | 10 |
| 13 | 0 | 23 | 0 | 2.660 | 2.645 | 2.629 | 2.613 | 2.596 | 2.578 | 2.559 | 2.540 | 2.519 | 2.496 | 2.473 | 1 0 | 11 0 |
| | 10 | 22 | 50 | .593 | .576 | .558 | .539 | .519 | .498 | .476 | .453 | .429 | .403 | .376 | 10 | 10 50 |
| | 20 | | 40 | .527 | .508 | .487 | .466 | .443 | .419 | .394 | .368 | .341 | .311 | .280 | 20 | 40 |
| | 30 | | 30 | .463 | .441 | .417 | .393 | .368 | .342 | .314 | .285 | .254 | .221 | .186 | 30 | 30 |
| | 40 | | 20 | .399 | .375 | .349 | .323 | .295 | .265 | .235 | .202 | .168 | .132 | .094 | 40 | 20 |
| | 50 | | 10 | .337 | .310 | .282 | .253 | .223 | .191 | .157 | .122 | .084 | 2.045 | 2.003 | 50 | 10 |
| 14 | 0 | 22 | 0 | 2.276 | 2.247 | 2.217 | 2.185 | 2.152 | 2.118 | 2.081 | 2.043 | 2.003 | 1.960 | 1.915 | 2 0 | 10 0 |
| | 10 | 21 | 50 | .216 | .185 | .153 | .119 | .084 | 2.046 | 2.007 | 1.966 | 1.923 | .877 | .828 | 10 | 9 50 |
| | 20 | | 40 | .158 | .125 | .091 | 2.055 | 2.017 | 1.977 | 1.935 | .892 | .845 | .796 | .744 | 20 | 40 |
| | 30 | | 30 | .102 | .067 | 2.031 | 1.992 | 1.952 | .910 | .866 | .819 | .770 | .718 | .663 | 30 | 30 |
| | 40 | | 20 | 2.048 | 2.011 | 1.972 | .932 | .890 | .845 | .798 | .750 | .697 | .642 | .584 | 40 | 20 |
| | 50 | | 10 | 1.996 | 1.957 | .916 | .874 | .829 | .782 | .733 | .682 | .627 | .569 | .508 | 50 | 10 |
| 15 | 0 | 21 | 0 | 1.946 | 1.905 | 1.863 | 1.818 | 1.771 | 1.722 | 1.671 | 1.617 | 1.559 | 1.499 | 1.435 | 3 0 | 9 0 |
| | 10 | 20 | 50 | .898 | .855 | .811 | .764 | .716 | .665 | .611 | .555 | .495 | .432 | .365 | 10 | 8 50 |
| | 20 | | 40 | .852 | .808 | .762 | .713 | .663 | .610 | .554 | .495 | .433 | .368 | .298 | 20 | 40 |
| | 30 | | 30 | .808 | .763 | .715 | .665 | .612 | .558 | .500 | .439 | .375 | .307 | .235 | 30 | 30 |
| | 40 | | 20 | .767 | .720 | .671 | .619 | .565 | .508 | .449 | .386 | .320 | .250 | .176 | 40 | 20 |
| | 50 | | 10 | .729 | .680 | .629 | .576 | .520 | .462 | .401 | .336 | .268 | .196 | .119 | 50 | 10 |
| 16 | 0 | 20 | 0 | 1.693 | 1.643 | 1.590 | 1.536 | 1.479 | 1.419 | 1.356 | 1.289 | 1.219 | 1.145 | 1.067 | 4 0 | 8 0 |
| | 10 | 19 | 50 | .659 | .608 | .555 | .499 | .440 | .379 | .314 | .246 | .174 | .099 | 1.018 | 10 | 7 50 |
| | 20 | | 40 | .628 | .576 | .521 | .464 | .405 | .342 | .276 | .207 | .133 | .056 | 0.974 | 20 | 40 |
| | 30 | | 30 | .600 | .547 | .491 | .433 | .372 | .308 | .241 | .170 | .096 | 1.017 | .933 | 30 | 30 |
| | 40 | | 20 | .575 | .521 | .464 | .405 | .343 | .278 | .210 | .138 | .062 | 0.982 | .896 | 40 | 20 |
| | 50 | | 10 | .553 | .498 | .440 | .380 | .317 | .251 | .182 | .109 | .032 | .950 | .864 | 50 | 10 |
| 17 | 0 | 19 | 0 | 1.533 | 1.478 | 1.419 | 1.359 | 1.295 | 1.228 | 1.158 | 1.084 | 1.006 | 0.923 | 0.836 | 5 0 | 7 0 |
| | 10 | 18 | 50 | .517 | .461 | .402 | .340 | .276 | .208 | .137 | .062 | 0.984 | .900 | .812 | 10 | 6 50 |
| | 20 | | 40 | .503 | .446 | .387 | .325 | .260 | .192 | .120 | .045 | .965 | .881 | .792 | 20 | 40 |
| | 30 | | 30 | .493 | .435 | .376 | .313 | .248 | .179 | .107 | .031 | .951 | .866 | .777 | 30 | 30 |
| | 40 | | 20 | .485 | .428 | .368 | .305 | .239 | .170 | .098 | .022 | .941 | .856 | .766 | 40 | 20 |
| | 50 | | 10 | .481 | .423 | .363 | .300 | .234 | .165 | .092 | .016 | .935 | .850 | .759 | 50 | 10 |
| 18 | 0 | 18 | 0 | 1.479 | 1.421 | 1.361 | 1.298 | 1.232 | 1.163 | 1.090 | 1.014 | 0.933 | 0.847 | 0.757 | 6 0 | 6 0 |

## XIV. DETERMINATION OF THE VALUE OF ONE REVOLUTION OF THE SCREW OF A SPHEROMETER MADE BY FAUTH AND CO., OF WASHINGTON, BY C. M. CONRADSON.

The spherometer is figured in position on page 42. It consists of a light German silver tripod carrying a steel micrometer screw. The weight of the whole spherometer is about one and a half ounces. The three legs are made of steel, and screw into the German silver frame. Their points are not hardened. The angle of these points is about 35°; of the point of the micrometer screw about 60°. All slack-motion of the screw is taken up by by a second nut. Those who are interested can see a figure of a similar device in the Article Micrometer in the Encyclopædia Britannica. vol XVI, page 244, figure 5 (*n n*).

### CONSTANTS OF THE SPHEROMETER.

We may call the three legs of the tripod *a, b, c; a,* is the leg to which the scale for reading whole revolutions is fixed, *b* is next to *a* in the order of decreasing readings of the micrometer head.

r′= distance from center of screw to leg *a*=1.30 inches.
r″= distance from center of screw to leg *b*=1.32 inches.
r‴= distance from center of screw to leg *c*=1.31 inches.
h′= distance which can be measured *above* the plane *abc*=0.50 inches.
h″= distance which can be measured *below* the plane *abc*=0.25 inches.

Diameter of screw=0.16 inches; 100 threads to the inch (approximately); length of nut=0.54 inches.

The distances from leg to leg are: *ab*=2.295 inches, *bc*=2.220 inches; *da*=2.290 inches. The radius of the circle, through the legs is therefore 1.310 inches, and the center of the micrometer screw is therefore 0.010 from the centre of the circle through the legs.

### OBSERVATIONS.

The observations consisted in measurement of the heights of two brass cylinders with plane ends, the property of Prof. HARKNESS, U. S. Navy, and kindly lent by him. The large

cylinder is denoted by A; the small cylinder by B. The logarithms of the heights of the two cylinders in inches are respectively 9.41486 and 9.69787.* The corrections to the heights of A. and B. for temperature have been neglected, as being almost inappreciable. The whole range of temperture was less than 7°. The zero of the spherometer was determined by taking readings upon a true plane of metal. The observations were made by taking a set of ten readings upon one of the cylinders, then a set of ten upon the plane surface, and then a set of ten upon the other cylinder, so that there are thirty measures in a complete set.

Table I contains a summary of these measures. The columns headed A and B contain the heights of the two cylinders in terms of a revolution of the spherometer screw. Each value as there given is the mean of ten measures.

TABLE I.

| No. | Date. | Temp. | A. | B. | No. | Date. | Temp. | A. | B. |
|---|---|---|---|---|---|---|---|---|---|
| | 1882. | F. | r. | r. | | 1882. | F. | r. | r. |
| 1 | Sep. 28 | 67° | 49.7864 | 25.9551 | 13 | Oct. 4 | 68° | 49.7829 | 25.9499 |
| 2 | 28 | 68 | .7834 | .9548 | 14 | 4 | 69 | .7810 | .9464 |
| 3 | 28 | 65 | .7850 | .9561 | 15 | 11 | 64 | .7814 | .9541 |
| 4 | 28 | 66 | .7874 | .9541 | 16 | 11 | 64 | .7803 | .9523 |
| 5 | 29 | 66 | .7862 | .9566 | 17 | 11 | 63 | .7794 | .9462 |
| 6 | 29 | 67 | .7849 | .9507 | 18 | 11 | 64 | .7793 | .9424 |
| 7 | 29 | 67 | .7845 | .9527 | 19 | 12 | 65 | .7814 | .9450 |
| 8 | 30 | 66 | .7832 | .9499 | 20 | 12 | 65 | .7861 | .9426 |
| 9 | 30 | 67 | .7826 | .9505 | 21 | 12 | 65 | .7819 | .9429 |
| 10 | Oct. 2 | 70 | .7869 | .9536 | 22 | 12 | 65 | .7779 | .9402 |
| 11 | 2 | 69 | .7846 | .9496 | 23 | 12 | 66 | .7827 | .9454 |
| 12 | Oct. 3 | 69 | 49.7841 | 25.9536 | 24 | Oct. 12 | 66 | 49.7809 | 25.9420 |

*See Washington Astronomical Observations for 1877, Appendix I, page 6.

Table II contains the probable error of the measures from which the results in Table I are derived.

TABLE II.

| No. | A. p. e. of the mean of ten measures. | A. p. e. of a single measure. | B. p. e. of the mean of ten measures. | B. p. e. of a single measure. |
|---|---|---|---|---|
| | r. | r. | r. | r. |
| 1 | ±0.0001 | ±0.0003 | ±0.0005 | ±0.0014 |
| 2 | .0005 | .0015 | .0005 | .0015 |
| 3 | .0005 | .0015 | .0008 | .0024 |
| 4 | .0003 | .0009 | .0006 | .0017 |
| 5 | .0005 | .0014 | .0004 | .0014 |
| 6 | .0006 | .0020 | .0007 | .0021 |
| 7 | .0005 | .0014 | .0004 | .0013 |
| 8 | .0008 | .0025 | .0007 | .0021 |
| 9 | .0008 | .0025 | .0006 | .0020 |
| 10 | .0009 | .0028 | .0008 | .0023 |
| 11 | .0007 | .0021 | .0009 | .0028 |
| 12 | .0002 | .0007 | .0005 | .0014 |
| 13 | .0005 | .0014 | .0003 | .0010 |
| 14 | .0005 | .0017 | .0007 | .0022 |
| 15 | .0005 | .0017 | .0008 | .0024 |
| 16 | .0005 | .0016 | .0009 | .0026 |
| 17 | .0006 | .0020 | .0004 | .0011 |
| 18 | .0006 | .0019 | .0006 | .0020 |
| 19 | .0007 | .0023 | .0006 | .0019 |
| 20 | .0005 | .0016 | .0006 | .0019 |
| 21 | .0009 | .0029 | .0007 | .0020 |
| 22 | .0005 | .0016 | .0009 | .0026 |
| 23 | .0010 | .0032 | .0008 | .0025 |
| 24 | ±0.0012 | ±0.0037 | ±0.0005 | ±0.0016 |

One revolution is about 0.01 inches.

From the data in Table I and the height of the cylinder in inches, the individual determinations of one revolution of the spherometer screw in inches are deduced. These follow, in Table III.

TABLE III.

| | | ONE REVOLUTION. | | | | ONE REVOLUTION. | |
|---|---|---|---|---|---|---|---|
| No. | Temp. | A. | B. | No. | Temp. | A. | B. |
| | ° | in. | in. | | ° | in. | in. |
| 1 | 67 | 0.010018 | 0.010015 | 13 | 68 | 0.010018 | 0.010017 |
| 2 | 68 | .010018 | .010015 | 14 | 69 | .010019 | .010018 |
| 3 | 65 | .010018 | .010014 | 15 | 64 | .010018 | .010015 |
| 4 | 66 | .010017 | .010015 | 16 | 64 | .010019 | .010016 |
| 5 | 66 | .010018 | .010014 | 17 | 63 | .010019 | .010013 |
| 6 | 67 | .010018 | .010016 | 18 | 64 | .010019 | .010020 |
| 7 | 67 | .010018 | .010016 | 19 | 65 | .010018 | .010019 |
| 8 | 66 | .010018 | .010017 | 20 | 65 | .010018 | .010019 |
| 9 | 67 | .010018 | .010016 | 21 | 65 | .010018 | .010019 |
| 10 | 70 | .010018 | .010015 | 22 | 65 | .010019 | .010024 |
| 11 | 69 | .010018 | .010017 | 23 | 66 | .010018 | .010018 |
| 12 | 69 | 0.010018 | 0.010015 | 24 | 66 | 0.010019 | 0.010020 |

In the course of the measures on cylinder B it was discovered that the two plane surfaces were not parallel to each other at all points. The results derived from the measures on B are assumed to be entitled to half weight. From an inspection of Table III, it will be seen that the range of temperature is too small to allow us to deduce a temperature co-efficient, and consequently taking the mean of the individual values we have.

One revolution = 0.010018 inches at 66 ° Fahr.

The probable error of this result is not above 0.000001 in. The observations were made in the most careful way and with every precaution against constant errors.

In connection with the foregoing work, a series of measures was made by Mr. CONRADSON, to determine the length of a PRATT and WHITNEY standard half-inch belonging to Professor HOLDEN. These measures and their results are given in Table IIII.

TABLE IV.

| No. | Date. | Temp. | Revolutions, | Inches. |
|---|---|---|---|---|
| | 1883. | ° | r | in |
| 1 | Jan. 8 | 60 | 49.8973 | 0.499873 |
| 2 | 8 | 60 | .8956 | .499854 |
| 3 | 8 | 59 | .8981 | .499879 |
| 4 | 8 | 59 | .8980 | .499878 |
| 5 | 8 | 59 | .8988 | .499886 |
| 6 | 8 | 59 | .8995 | .499893 |
| 7 | 8 | 59 | .8989 | .499888 |
| 8 | 8 | 58 | .8960 | .499869 |
| 9 | 8 | 58 | .8980 | .499889 |
| 10 | Jan. 10 | 53 | 49.9000 | 0.499899 |

The length of this end-measure is then 0.499881 in., at 58° F. log 9.698867.

The probable error of the result is about 0.000003 in.

## XV. ON A NEW METHOD OF OBSERVING WITH THE PRIME VERTICAL TRANSIT, BY GEORGE C. COMSTOCK.

More than half a century ago BESSEL introduced into practical astronomy the observation of stars by reflection from mercury, and the method has come into common use in meridian observations, but so far as I am aware, it has never been applied to transits over the prime vertical.* It is the purpose of this article to indicate the value of such observations and to develop the formulæ for their reduction.

Let $a$ and $b$ denote the altitude and azimuth of the point in which the rotation axis of a transit instrument, mounted approximately in the prime vertical, intersects the celestial sphere when produced toward the north. Denote by $A$, $t$, and $z$ the azimuth, hour-angle, and zenith-distance of a star at the instant of its transit over a thread whose angular distance north of the collimation axis is $c$. Azimuths will be reckoned from the north point towards the east, and hour-angles from the meridian towards the west. Let T be the true sidereal time of transit of a star whose co-ordinates are $\alpha$ and $\delta$, over the thread c.

The general equation of the transit instrument as developed by BESSEL (*Astr. Nach.* 6, p. 221; *Abh.* 64, vol. ii, p. 45), furnishes the relation

$$\sin. z \cos. b \cos (A-a) + \cos z \sin b + \sin c = 0 \quad (1.)$$

between these quantities. Developing the first term of this equation and substituting for sin z cos A and sin z sin A their values in terms of $\varphi$, $\delta$, and t, we shall have for each observed wire an equation of the form

$$\cos \delta \sin \varphi \cos t - \cos \delta \operatorname{tg} a \sin t = \sin \delta \cos \varphi + \frac{\cos z \sin b}{\cos a \cos b} + \frac{\sin c}{\cos a \cos b} \quad (2.)$$

which expresses the relation among the quantities for both direct and reflex observations. These several equations may

*The method was proposed and its advantages stated in Washington Astronomical Observations for 1845, page [ix] but no practical application of it was made at Washington.—E. S. H.

be united into one by the method given in BESSEL'S article above cited, If $n$ denote the number of threads observed at a transit of the star over one vertical, the mean of the $n$ resulting equations will be

$$\cos\delta \sin\varphi \frac{1}{n}\Sigma\cos t - \cos\delta \operatorname{tg} a \frac{1}{n}\Sigma\sin t = \sin\delta\cos\varphi + \frac{\sin b \frac{1}{n}\Sigma\cos z}{\cos a \cos b} + \frac{\frac{1}{n}\Sigma \sin c}{\cos a \cos b} \quad (3.$$

For any thread, t is found from the equation

$$t = T - \alpha.$$

$$\text{Put } \tau = \frac{1}{n}\Sigma T - \alpha. \qquad h = t - \tau = T - \frac{1}{n}\Sigma T$$

and the first member of equation (3) becomes

$$(\cos\delta \sin\varphi \cos\tau - \cos\delta \operatorname{tg} a \sin\tau)\frac{1}{n}\Sigma\cos h -$$

$$(\cos\delta \sin\varphi \sin\tau + \cos\delta \operatorname{tg} a \cos\tau)\frac{1}{n}\Sigma \sin h$$

Assume the auxiliary quantities.

$$q\cos\psi = \sin\varphi \qquad \frac{1}{k}\cos K = \frac{1}{n}\Sigma\cos h$$

$$q\sin\psi = \operatorname{tg} a \qquad \frac{1}{k}\sin K = -\frac{1}{n}\Sigma\sin h$$

and the preceeding expression becomes

$$\frac{\cos\delta\sin\varphi\cos(\tau+\psi-K)}{k\cos\psi} = \sin\delta\cos\varphi + \frac{\sin b \frac{1}{n}\Sigma\cos z}{\cos a\cos b} + \frac{\frac{1}{n}\Sigma\sin c}{\cos a\cos b} \quad (5)$$

The quantities k and K are easily obtained with the argument h from the tables given by BESSEL and reproduced in CHAUVENET'S Spherical Astronomy.

$$k = 1 + \frac{1}{n}\Sigma\frac{2\sin^2\frac{1}{2}h}{\sin 1''}\cdot\sin 1''$$

$$K = \frac{\frac{1}{n}\Sigma(h - \sin h)}{\sin 1''}.$$

The equation (5.) is readily transformed into

$$\text{Sin}\,(\varphi - \delta) = \cos\delta \sin\varphi\, 2 \sin^2\tfrac{1}{2}(\tau + \psi - K)$$
$$+ \frac{\sin b \frac{1}{n}\Sigma \cos z}{\cos a \cos b} + \frac{\frac{1}{n}\Sigma \sin c}{\cos a \cos b}$$
$$- \cos\delta \sin\varphi \cos(\tau + \psi - K)\ \frac{1 - k\cos\psi}{k\cos\psi}$$

The last term in this expression may be made to disappear by computing the quantity.

$$\sigma = \cot(\tau + \psi - K)\left[\frac{2\sin^2\tfrac{1}{2}\psi}{\sin 1''} - \frac{1}{n}\Sigma\frac{2\sin^2\tfrac{1}{2}h}{\sin 1''}\right]$$

By the aid of which (6) is transformed into

$$\sin(\varphi - \delta) = \cos\delta \sin\varphi\, 2\sin^2\tfrac{1}{2}(\tau + \psi - K - \sigma)$$
$$+ \frac{\sin b \frac{1}{n}\Sigma \cos z}{\cos a} + \frac{\frac{1}{n}\Sigma \sin c}{\cos a} \quad (7)$$

in which cos b has been put equal to 1.

By observing a star at its transit over the east and west verticals and by reversing the instrument between the transits, errors of azimuth, collimation and thread intervals may be eliminated, and errors of level are the only ones of a systematic character with which the results of a well arranged series of prime vertical transits are affected. Equation (7.) shows that if an equal number of threads are observed direct and reflected, this source of error will also be removed, since in that case $\Sigma \cos z$ will differ very little from zero, and being multiplied by the small quantity $b$, it may usually be assumed zero.

Should an extreme case require it $\Sigma \cos z$ is easily computed from the readings of the setting circle.

The advantages of a broken transit for reflex observations are obvious and the formula shows that the principal flexure term of such an instrument, which is of the form f cos z, is also eliminated.

The reduction of the reflex observations will be made in precisely the same way as the direct ones, the observed times T, both direct and reflex, being united into one mean thus avoiding the necessity of reducing each wire separately.

Formula (7) has been developed for the case of a transit over one vertical in order to show that the inclination of the axis may be eliminated for each vertical by a proper combination of observations and that no assumption need be made in regard to the stability of the instrument in level between the transits over the east and west verticals.

The formulae for the ordinary case of a transit over both the east and west verticals are easily derived from the preceding equations.

$$\text{Put } \tau_1 = \frac{1}{n}\Sigma T_1 - K_1 - \sigma_1 - \alpha$$

$$\tau_2 = \frac{1}{n}\Sigma T_2 - K_2 - \sigma_2 - \alpha$$

in which the subscripts 1 and 2 refer respectively to the transits over the east and west verticals. We have then:

$$\sin(\varphi - \delta) = \cos\delta \sin\varphi [1 - \cos(\tau_1 + \psi)] + \frac{\frac{1}{n}\Sigma \cos z_1}{\cos a} b_1 \sin 1'' + \frac{\frac{1}{n}\Sigma c_1}{\cos a} \sin 1''$$

$$\sin(\varphi - \delta) = \cos\delta \sin\varphi [1 - \cos(\tau_2 + \psi)] + \frac{\frac{1}{n}\Sigma \cos z_2}{\cos a} b_2 \sin 1'' + \frac{\frac{1}{n}\Sigma c_2}{\cos a} \sin 1''$$

Denoting by $\gamma_1$ and $\gamma_2$ the sum of the terms depending upon b and c for the east and west transits respectively, the mean of these equations gives

$$\sin(\varphi - \delta) = \cos\delta \sin\varphi \left[1 - \cos\left(\frac{\tau_2 + \tau_1}{2} + \psi\right) \cos\left(\frac{\tau_2 - \tau_1}{2}\right)\right] + \frac{\gamma_2 + \gamma_1}{2} \quad (8.)$$

$$\text{Put now } \omega = \cot\tfrac{1}{2}(\tau_2 - \tau_1) \frac{2\sin^2\frac{1}{2}\left(\frac{\tau_2 + \tau_1}{2} + \psi\right)}{\sin 1''}$$

And equation 8 becomes

$$\sin(\varphi - \delta) = \cos\delta \sin\varphi \; 2\sin^2\tfrac{1}{2}\left(\frac{\tau_2 - \tau_1}{2} + \omega\right) + \tfrac{1}{2}(\gamma_2 + \gamma_1) \quad (9.)$$

The term $\frac{1}{2}(\gamma_2 + \gamma_1)$ may be made to disappear by properly combining the observations. as has been already indicated.

If the instrument is properly adjusted, the quantity $\psi$ in the expression for $\omega$ may be neglected, and the formulæ reduced to

$$\omega = \cot \tfrac{1}{2}(\tau_2 - \tau_1) \frac{2 \sin^2 \frac{1}{2} \frac{\tau_2 + \tau_1}{2}}{\sin 1''}$$

$$\sin(\varphi - \delta) = \cos \delta \sin \varphi \, 2 \sin^2 \tfrac{1}{2} \left( \frac{\tau_2 - \tau_1}{2} + \omega \right)$$

For $\frac{\tau_2}{2}^{1}$ we may write $\frac{1}{2}\left(\frac{1}{n} \Sigma T_2 + \frac{1}{n} \Sigma T_1\right) - \alpha$ and for $\frac{\tau_2 - \tau_1}{2}$, $\frac{1}{2}\left[ \left(\frac{1}{n} \Sigma T_2 - \sigma_2 - K_2\right) - \left(\frac{1}{n} \Sigma T_1 - \sigma_1 - K_1\right) \right]$ in which the quantities $K_1$ and $K_2$ will usually be insensible.

It is evident that those stars for which $\varphi - \delta$ is very small; cannot be observed in the prime vertical by reflection, and it is a matter of some interest to know how great must be the difference between the declination and latitude to allow such observations to be made. This will depend mainly upon the distance from the objective of the telescope at which the mercury basin can be placed. A simple geometrical construction will show that the limiting value of z for which the reflected rays from the star will fall upon every portion of the objective is given approximately by the equation $\sin z = \frac{a}{2d}$.

Where $a$ is the diameter of the object end of the telescope and $d$ is the vertical distance of the center of the objective above the reflecting surface. From the figures contained in the *Description de l'Observatoire de Pulkova* and the first volume of the *Washington Observations*, I have computed for the prime vertical instruments of those two observatories the limiting values of $\varphi - \delta$ within which reflex observations cannot be made in the prime vertical, using for $d$ the distance from the objective to the floor when the telescope is pointed to the nadir. I find for

Pulkova, $\varphi - \delta = 0.^\circ 6$ $z = 6.^\circ 1$.
Washington, $\varphi - \delta = 0.2$ $z = 3.9$.

The quantity z is the corresponding zenith distance in the prime vertical.

In investigations in which the highest degree of accuracy is sought, such as the determination of the constant of aberration, annual parallax, etc., the elimination of the inclination of the rotation axis is a matter of prime importance, and the increased labor of the observations will be well repaid by the removal of one source of error. In the case of field instruments of the ordinary construction the limits of declination imposed upon the method may be such as to prevent its convenient application, but with the *Steinheil* broken transit, in which the objective and ocular are at the extremities of the axis, I see no reason why it should not be employed in the field.

OCTOBER, 1883.

## XVI. INVESTIGATION OF THE MICROMETER OF THE FIFTEEN INCH EQUATORIAL, BY MR. JOHN TATLOCK.

The screw of this micrometer, which was made by CLARK, was investigated by Professor HOLDEN at Washington in February 1881, on the "Ruled Glass Scale Micrometer," belonging to the United States Naval Observatory. The method of making the observations is fully detailed in the *Washington Observations* for 1877.—Appendix I. The observations have been reduced by Mr. TATLOCK.

The value of one revolution of the screw of this Micrometer is 10″.48. The object of the investigation was: *First*: To determine the inequalities of the several whole revolutions from 43$^{r}$ to 87$^{r}$. *Second*: To determine the periodic errors of the part of the screw most used. *Third*: To determine the length of the mean revolution in inches at 32° Fahrenheit. Table I contains the corrections required to reduce each revolution of the screw to the mean value of a single revolution derived from all the observations. Table I*a* contains these corrections for those revolutions which were twice measured, and the mean of the two.

The probable error of each single correction in these tables is ± 0″.02.

These tables especially the table I*a*, show that the data are not sufficient to determine definitive corrections to each whole revolution, and they also show that such corrections are very small.

To determine the periodic inequalities of the screw, the length of every tenth of a revolution was determined. Table II contains the residuals found by subtracting the individual values of one-tenth revolution from the mean value. The probable error of a single measure is about 0″.02, and of the mean of 10 about 0″.006.

TABLE I.

| Revolutions. | Corrections. | Revolutions. | Corrections. | Revolutions. | Corrections. |
|---|---|---|---|---|---|
| r r | " | r r | " | r r | " |
| 43—44 | —0.063 | 58—59 | —0.021 | 73—74 | +0.021 |
| 44—45 | +0.042 | 59—60 | —0.031 | 74—75 | —0.042 |
| 45—46 | —0.052 | 60—61 | +0.105 | 75—76 | +0.021 |
| 46—47 | 0.000 | 61—62 | —0.021 | 76—77 | 0.000 |
| 47—48 | —0.021 | 62—63 | —0.021 | 77—78 | —0·021 |
| 48—49 | +0.042 | 63—64 | +0.031 | 78—79 | +0.063 |
| 49—50 | +0.031 | 64—65 | —0.084 | 79—80 | —0.105 |
| 50—51 | —0.042 | 65—66 | —0.010 | 80—81 | +0.021 |
| 51—52 | —0.031 | 66—67 | +0.031 | 81—82 | +0.094 |
| 52—53 | —0.010 | 67—68 | +0.021 | 82—83 | —0.031 |
| 53—54 | —0.052 | 68—69 | +0.010 | 83—84 | +0.042 |
| 54—55 | —0.021 | 69—70 | +0.010 | 84—85 | —0.063 |
| 55—56 | +0.084 | 70—71 | —0.021 | 85—86 | —0.042 |
| 56—57 | —0.052 | 71—72 | —0.010 | 86—87 | +0.042 |
| 57—58 | —0.010 | 72—73 | +0·063 | | |

TABLE I*a*.

| Revolutions. | Corrections. | Corrections. | Mean. |
|---|---|---|---|
| r. r. | " | " | " |
| 63—64 | +0.031 | —0.021 | +0.005 |
| 64—65 | —0.084 | +0.021 | —0.031 |
| 65—66 | —0.010 | 0.000 | —0.005 |
| 66—67 | +0.031 | +0.010 | +0.020 |
| 67—68 | +0.021 | 0.000 | +0.010 |
| 70—71 | —0.031 | 0.000 | —0.015 |
| 71—72 | —0.021 | —0.021 | —0.021 |
| 72—73 | +0.052 | +0.021 | +0.036 |

TABLE II.

| Rev. | 0 to .1. | .1 to .2. | .2 to .3. | .3 to .4. | .4 to .5. | .5 to .6. | .6 to .7. | .7 to .8. | .8 to .9. | .9 to 0.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| | " | " | " | " | " | " | " | " | " | " |
| 63 | 0.000 | —0.010 | —0.021 | —0.010 | +0.021 | —0.031 | +0.010 | —0.010 | +0.021 | +0.031 |
| 64 | +0.010 | +0.031 | +0.010 | +0.010 | —0.073 | +0.052 | 0.000 | +0.021 | —0.031 | +0.010 |
| 65 | +0.021 | +0.031 | +0.021 | +0.052 | +0.010 | —0.010 | —0.031 | +0.042 | —0.010 | 0.000 |
| 66 | —0.031 | +0.021 | +0.031 | +0.010 | —0.052 | +0.010 | 0.000 | +0.010 | +0.031 | —0.021 |
| 67 | +0.010 | 0.000 | 0.000 | +0.021 | —0.031 | —0.021 | 0.000 | +0.031 | +0.010 | 0.000 |
| 68 | —0.042 | +0.031 | +0.031 | +0.010 | 0.000 | +0.052 | —0.063 | +0.010 | —0.010 | +0.031 |
| 69 | 0.000 | +0.010 | —0.021 | +0.010 | +0.031 | —0.010 | +0.031 | —0.021 | +0.010 | 0.000 |
| 70 | +0.010 | —0.021 | +0.031 | +0.021 | +0.031 | —0.031 | —0.010 | +0.031 | —0.021 | +0.021 |
| 71 | —0.031 | +0.031 | +0.031 | 0.000 | —0.031 | 0.000 | +0.010 | +0.010 | 0.000 | —0.021 |
| 72 | +0.031 | —0.010 | +0.031 | —0.021 | +0.010 | 0.000 | —0.021 | +0.010 | +0.021 | —0.010 |
| Σ | —0.022 | +0.114 | +0.144 | +0.103 | —0.084 | +0.011 | —0.074 | +0.134 | +0.021 | +0.041 |
| No. obs. | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Mean. | —0.002 | +0.011 | +0.014 | +0.010 | —0.008 | +0.001 | —0.007 | +0.013 | +0.002 | +0.004 |

If we assume that the correction for the periodic error of the screw can be expressed by an equation of the form $m = a \sin u + b \cos u$ where $m$ is the correction, $u$ is the angle through which the screw is turned, and $a$ and $b$ coefficients, and if we determine the values of $a$ and $b$ from the data in Table II, we shall find that the maximum value of the correction does not amount to $0''.02$. We may safely say that the periodic inequalities of this screw, from $63^r$ to $73^r$, are far less than the accidental errors of the measures which can be made with it, and need not be further considered.

In order to determine the value of the mean revolution of the screw in inches, we assume the coefficient of expansion of the steel screw, which is 0.00000680, so that the length of one revolution of the screw at t° Fahrenheit is (assuming its length at 32° Fahrenheit as unity), 1+0.00000680 (t°—32°), or 1+[4.832509] (t°—32°).

TABLE III. LENGTH OF ONE REVOLUTION IN INCHES.

| Date, 1881. | Temperature. | Limiting Revolutions. | No. of Revolutions. | No. of Scale Divisions. | No. of Revolutions at 32° Fr. | No. of inches at 32° Fr. | 1 Revolution at 32° Fr. | Wt. |
|---|---|---|---|---|---|---|---|---|
| | ° | r r | | d | r | in. | in. | |
| Feb. 15 | 59.0 | 78—85 | 7 | 4.408 | 7.001285 | 0.087673 | 0.01250 | 1 |
| 15 | 59.0 | 85—88 | 3 | 1.892 | 3.000551 | 0.037630 | 0.01254 | 1 |
| 15 | 59.0 | 43—88 | 45 | 27.717 | 46.008262 | 0.551277 | 0.01225 | 9 |
| 16 | 60.0 | 43—46 | 3 | 1.891 | 3.000571 | 0.037611 | 0.01254 | 1 |
| 16 | 61.0 | 46—53 | 7 | 4.399 | 7.001380 | 0.087495 | 0.01250 | 1 |
| 16 | 61.0 | 53—59 | 6 | 3.775 | 6.001183 | 0.075084 | 0.01250 | 1 |
| 16 | 62.0 | 59—65 | 6 | 3.770 | 6.001224 | 0.074985 | 0.01250 | 1 |
| 16 | 62.0 | 65—72 | 7 | 4.393 | 7.001428 | 0.087376 | 0.01248 | 1 |
| 16 | 62.0 | 72—78 | 6 | 3.764 | 6.001224 | 0.074865 | 0.01248 | 1 |
| 18 | 59.0 | 63—69 | 5.8 | 3.640 | 5.801065 | 0.072398 | 0.01248 | 1 |
| 21 | 64.0 | 69—73 | 3.7 | 2.320 | 3.700805 | 0.046145 | 0.01247 | 1 |
| 21 | 64.5 | 43—88 | 4.5 | 27.716 | 45.009945 | 0.552053 | 0.01226 | 9 |
| 25 | 58.5 | 20—45 | 24.649 | 15.499 | 24.653442 | 0.308625 | 0.01251 | 5 |

Taking the mean by weights, we conclude that the value of one revolution in inches at 32° F. = 0.012369, log. 8.092335. The focal length of the telescope at 32° F. is then 243.44. in.

INVESTIGATION OF THE POSITION CIRCLE.

The position circle of the micrometer was investigated by Mr. TATLOCK, on February 10, 1884, by setting Vernier A at every 10° of the circle and noting the corresponding readings of Vernier B. These observations are given in the following table. Each reading there set down is the mean of three separate settings and readings.

| Ver. A | Ver. B | | Ver. A | Ver. B | | Ver. A | Ver. B | |
|---|---|---|---|---|---|---|---|---|
| ° | ° | ′ | ° | ° | ′ | ° | ° | ′ |
| 0 | 179 | 56.0 | 120 | 299 | 56.7 | 240 | 59 | 56.7 |
| 10 | 189 | 55.3 | 130 | 309 | 54.0 | 250 | 69 | 56.7 |
| 20 | 199 | 55.7 | 140 | 319 | 55.7 | 260 | 79 | 57.0 |
| 30 | 209 | 55.3 | 150 | 329 | 55.3 | 270 | 89 | 55.7 |
| 40 | 219 | 55.0 | 160 | 339 | 56.0 | 280 | 99 | 57.3 |
| 50 | 229 | 55.0 | 170 | 349 | 56.0 | 290 | 109 | 58.0 |
| 60 | 239 | 54.3 | 180 | 359 | 56.0 | 300 | 119 | 57.0 |
| 70 | 249 | 54.7 | 190 | 9 | 57.0 | 310 | 129 | 58.7 |
| 80 | 259 | 54.3 | 200 | 19 | 56.3 | 320 | 139 | 58.7 |
| 90 | 269 | 54.7 | 210 | 29 | 56.7 | 330 | 149 | 56.3 |
| 100 | 279 | 55.3 | 220 | 39 | 57.0 | 340 | 159 | 56.7 |
| 110 | 289 | 54.7 | 230 | 49 | 56.3 | 350 | 169 | 56.3 |

Where the observations are recorded to the nearest 0°.1, as is usual, either vernier may be employed. For readings to single minutes both verniers must be read.

## XVII. METEOROLOGICAL OBSERVATIONS AT MADISON, DURING 1882–1883.

In continuation of the data for the years 1872–1881, inclusive, given in *Publications of the Washburn Observatory*, Vol. I, page 169, *et seq.*, I give here the data for the years 1882 and 1883. From 1882 January 1, to 1883 March 31, they are derived from observations taken at the U. S. Signal Station, in the City of Madison, by the Signal Observer, Mr. C. A. SHAW. On 1883, April 1, the Signal Station in Madison was abandoned, and the instruments were transferred to the University. They were temporarily mounted on the roof of the North Dormitory and the observations of 1883 May 1 to 1883 July 31, were made there by Mr. J. C. OFFICER, a student at the University.

In August they were mounted at the Observatory, where they will remain. The observations of August to December 12, 1883, were made by Mr. TATLOCK, assistant, and since then by Mr. GEORGE W. BROWN, a student in the University.

The instruments are 1st, a large Signal Service Wind Vane. This is mounted on the east wing and the arrow is some forty feet above the ground. The exposure is good except that the dome makes a lee for westerly winds. The small vane on the Student's Observatory can be used as a check. The large vane is read by means of a dial and pointer in the ceiling of the bed room assigned to the meteorological observer.

2d. A ROBINSON'S anemometer on the southeast angle of the building. Its revolving cups are 38 feet above the ground. It is in the lee of the dome (some 70 feet distant) for westerly winds. The anemometer is of the Signal Service pattern and automatically registers each mile of wind traveled on a chronograph barrel in the hall.

3d. A rain guage is placed on the roof near the anemometer. It is 24 feet above the ground. A rain guage on the ground has also been read at times.

4th. Two mercurial barometers are hung in the clock room. Their cisterns are 961 feet above sea level. The observatory barometer has been moved to the Meridian Circle room.

5th. Wet and dry bulb thermometers are placed in the Thermometer Shelter outside of the Meridian Circle room. These instruments are the property of the U. S. Signal Service, and are additional to the instruments of the Observatory described in vol. I., p. 31. The observations are made at 7 A. M., 2 P. M., and 9 P. M. daily, local mean time.

It should be noticed that the mean daily barometer and the mean daily thermometer relate to the civil day beginning at 12 midnight. The Maximum and Minimum thermometers relate to the day from 9 P. M. to 9 P. M. The maximum velocity of wind, and the number of miles traveled by the wind relate to the day from 2 P. M. to 2 P. M.

METEOROLOGICAL RECORD FOR THE MONTH OF JANUARY, 1882.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind. | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ° | ° | Miles. | | Inch's |
| 1 | 29.097 | 22 | 7 | 15.3 | 22 | 220 | ..... |
| 2 | 29.078 | 24 | 15 | 17.3 | 9 | 122 | .01 |
| 3 | 29.285 | 25 | 10 | 17.3 | 14 | 181 | ..... |
| 4 | 29.381 | 25 | 18 | 21.0 | 22 | 262 | —* |
| 5 | 29.236 | 35 | 19 | 27.0 | 15 | 150 | ..... |
| 6 | 28.920 | 37 | 24 | 31.3 | 15 | 218 | .10 |
| 7 | 28.796 | 38 | 31 | 35.0 | 15 | 207 | .06 |
| 8 | 28.805 | 35 | 23 | 29.7 | 24 | 309 | .02 |
| 9 | 29.128 | 41 | 24 | 33.0 | 20 | 228 | ..... |
| 10 | 28.986 | 37 | 29 | 32.7 | 12 | 131 | .49 |
| 11 | 29.188 | 34 | 23 | 28.7 | 16 | 188 | .15 |
| 12 | 29.190 | 32 | 9 | 22.7 | 12 | 106 | ..... |
| 13 | 28.802 | 35 | 8 | 24.0 | 28 | 245 | .06 |
| 14 | 28.854 | 26 | —5 | 14.3 | 23 | 297 | ..... |
| 15 | 28.815 | 33 | 20 | 25.3 | 24 | 228 | ..... |
| 16 | 29.191 | 22 | 1 | 5.0 | 25 | 249 | ..... |
| 17 | 29.155 | 17 | —6 | 5.7 | 20 | 268 | ..... |
| 18 | 28.940 | 27 | 9 | 17.0 | 24 | 329 | ..... |
| 19 | 29.132 | 30 | 6 | 19.0 | 15 | 172 | ..... |
| 20 | 28.881 | 37 | 17 | 31.0 | 14 | 196 | —* |
| 21 | 28.990 | 35 | 14 | 25.0 | 32 | 342 | —* |
| 22 | 29.482 | 15 | 2 | 6.7 | 24 | 288 | ..... |
| 23 | 29.627 | 7 | —8 | —0.3 | 13 | 209 | ..... |
| 24 | 29.186 | 29 | 3 | 21.7 | 18 | 243 | .02 |
| 25 | 28.661 | 42 | 28 | 37.7 | 17 | 256 | .09 |
| 26 | 28.651 | 48 | 26 | 37.0 | 38 | 278 | .33 |
| 27 | 29.090 | 41 | 19 | 32.0 | 16 | 213 | ..... |
| 28 | 29.108 | 36 | 3 | 15.7 | 32 | 462 | ..... |
| 29 | 29.348 | 19 | —1 | 11.3 | 24 | 281 | ..... |
| 30 | 28.919 | 38 | 16 | 27.3 | 25 | 328 | ..... |
| 31 | 28.676 | 34 | 23 | 27.7 | 12 | 174 | ..... |
| Means. | 29.052 | 30.8 | 13.1 | 22.4 | Sums. | 7480 | 1.33 |

Highest barometer, 29,679 in.; lowest, 28.307 in.; highest temperature, 48°; lowest —8.0°, maximum velocity of wind, 38 miles; prevailing winds S., N. W. and W.; No. of cloudy days, 10; No. of fair days, 17; No. of clear days, 4; range of thermometer, 56°; range of barometer, 1.372 in.

Memoranda. No. of times wind blew from N., 3; E., 3; S., 25; W.. 17; N. E., 8; S. E, 10; S. W., 11; N. W., 16. (Observed every eight hours.)

* Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF FEBRUARY, 1882.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind. | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ° | ° | Miles. | | Inch's |
| 1 | 28.824 | 35 | 26 | 30.0 | 25 | 329 | ..... |
| 2 | 28.892 | 40 | 24 | 32.0 | 25 | 341 | ..... |
| 3 | 28.939 | 48 | 22 | 34.3 | 25 | 278 | ..... |
| 4 | 28.757 | 37 | 25 | 31.3 | 25 | 287 | ..... |
| 5 | 28.828 | 42 | 30 | 34.7 | 24 | 206 | ——* |
| 6 | 29.804 | 54 | 30 | 42.3 | 17 | 219 | ..... |
| 7 | 28.939 | 46 | 25 | 34.0 | 25 | 326 | ..... |
| 8 | 29.034 | 41 | 22 | 30.0 | 15 | 177 | ..... |
| 9 | 28.897 | 47 | 24 | 35.0 | 28 | 250 | ..... |
| 10 | 29.168 | 44 | 27 | 36.0 | 19 | 248 | ..... |
| 11 | 28.961 | 51 | 35 | 43.7 | 20 | 295 | .01 |
| 12 | 28.764 | 63 | 45 | 51.0 | 30 | 389 | ..... |
| 13 | 29.012 | 46 | 29 | 35.7 | 25 | 338 | ..... |
| 14 | 28.976 | 49 | 29 | 38.0 | 19 | 246 | ..... |
| 15 | 28.851 | 56 | 34 | 43.3 | 20 | 319 | ..... |
| 16 | 28.932 | 54 | 32 | 39.3 | 20 | 218 | ..... |
| 17 | 29.503 | 30 | 16 | 22.7 | 24 | 414 | ——* |
| 18 | 29.088 | 40 | 25 | 34.0 | 23 | 398 | .63 |
| 19 | 29.135 | 39 | 20 | 27.3 | 22 | 326 | .03 |
| 20 | 28.797 | 28 | 17 | 24.7 | 27 | 379 | .08 |
| 21 | 28.595 | 28 | 16 | 19.7 | 30 | 450 | .25 |
| 22 | 29.030 | 16 | 4 | 10.0 | 20 | 352 | ..... |
| 23 | 29.241 | 26 | 10 | 19.3 | 13 | 202 | ..... |
| 24 | 29.375 | 36 | 13 | 24.3 | 13 | 133 | ..... |
| 25 | 29.150 | 46 | 27 | 39.0 | 20 | 311 | .05 |
| 26 | 29.044 | 44 | 38 | 40.7 | 14 | 134 | .04 |
| 27 | 28.803 | 47 | 37 | 43.3 | 24 | 257 | .34 |
| 28 | 28.473 | 47 | 40 | 43.3 | 16 | 186 | .22 |
| Means. | 28.958 | 42.2 | 25.8 | 35.5 | Sums.. | 8008 | 1.74 |

Highest barometer, 29.605 in.; lowest, 28.332 in. Highest temperature, 63°; lowest, 4°. Maximum velocity of wind, 30 miles. Prevailing winds, S., W., S. W., S. E. No. of cloudy days, 8; No. of fair days, 13; No. of clear days, 7. Range of thermometer, 59°. Range of barometer, 1·273 in.

Memoranda: No. times the wind blew from the N., 2; E., 4; S., 23; W., 18; N. E., 4; S, E., 13; S. W., 14; N. W., 4. (Observations once in eight hours.

* Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF MARCH, 1882.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind. | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ° | ° | Miles. | | Inch's |
| 1 | 28.709 | 62 | 37 | 47.7 | 18 | 213 | ..... |
| 2 | 29.040 | 61 | 37 | 45.3 | 20 | 175 | ..... |
| 3 | 29.248 | 50 | 34 | 40.3 | 13 | 188 | ..... |
| 4 | 28.867 | 43 | 33 | 38.3 | 33 | 519 | .58 |
| 5 | 28.757 | 43 | 32 | 35.7 | 25 | 385 | ..... |
| 6 | 29.148 | 32 | 23 | 25.3 | 22 | 356 | —* |
| 7 | 29.550 | 29 | 15 | 22.0 | 17 | 249 | —* |
| 8 | 29.287 | 36 | 23 | 30.0 | 13 | 211 | .13 |
| 9 | 28.833 | 30 | 25 | 26.7 | 34 | 484 | .66 |
| 10 | 29.200 | 35 | 25 | 29.7 | 20 | 257 | ..... |
| 11 | 29.090 | 33 | 26 | 29.3 | 15 | 181 | .05 |
| 12 | 28.865 | 33 | 22 | 26.7 | 24 | 301 | .01 |
| 13 | 29.092 | 34 | 17 | 25.7 | 20 | 278 | —* |
| 14 | 29.059 | 39 | 27 | 32.3 | 21 | 274 | .25 |
| 15 | 28.982 | 37 | 32 | 34.7 | 16 | 218 | .05 |
| 16 | 29.232 | 40 | 31 | 35.7 | 20 | 184 | ..... |
| 17 | 28.841 | 38 | 34 | 36.7 | 25 | 449 | .32 |
| 18 | 28.800 | 49 | 35 | 39.0 | 22 | 270 | .08 |
| 19 | 29.104 | 48 | 30 | 39.0 | 15 | 158 | ..... |
| 20 | 28.664 | 43 | 35 | 38.7 | 28 | 418 | .74 |
| 21 | 28.652 | 39 | 19 | 34.3 | 32 | 503 | .07 |
| 22 | 29.258 | 39 | 22 | 29.7 | 30 | 372 | —* |
| 23 | 29.130 | 49 | 22 | 34.0 | 30 | 443 | ..... |
| 24 | 29.331 | 35 | 14 | 23.7 | 28 | 276 | ..... |
| 25 | 28.846 | 43 | 31 | 36.0 | 25 | 326 | .35 |
| 26 | 28.516 | 49 | 35 | 39.7 | 12 | 118 | .95 |
| 27 | 28.691 | 43 | 33 | 36.7 | 25 | 415 | .49 |
| 28 | 29.762 | 50 | 32 | 41.7 | 28 | 372 | ..... |
| 29 | 28.723 | 58 | 36 | 45.0 | 28 | 514 | ..... |
| 30 | 29.361 | 41 | 27 | 32.3 | 25 | 318 | ..... |
| 31 | 29.143 | 57 | 31 | 43.3 | 24 | 309 | ..... |
| Means. | 28.993 | 42.5 | 28.2 | 34.4 | Sums. | 9734 | 4.73 |

Highest barometer, 29.584 inches; lowest, 28.319 inches; highest temperature, 62°; lowest, 14°; maximum velocity of wind, 34 miles; prevailing winds, N. W., S. E., N. E., W.; No. of cloudy days, 13; No. of fair days, 18; No. of clear days, 0; range of thermometer, 48°; range of barometer, 1.265 inches.

Memoranda: No. of times wind blew from the N. 12; E. 12; S. 7; W. 12; N. E., 6; S. E., 13; S. W. 6; N. W., 25. (Observations once in eight hours.)

*Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF APRIL, 1882.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ° | ° | Miles. | | Inch's |
| 1 | 28.834 | 78 | 46 | 62.0 | 18 | 256 | .12 |
| 2 | 29.104 | 70 | 48 | 55.7 | 25 | 202 | ..... |
| 3 | 29.019 | 73 | 41 | 59.0 | 20 | 275 | .02 |
| 4 | 29.063 | 66 | 34 | 45.7 | 25 | 331 | .17 |
| 5 | 29.059 | 42 | 33 | 38.0 | 21 | 332 | .48 |
| 6 | 28.702 | 68 | 41 | 54.7 | 44 | 449 | .37 |
| 7 | 29.106 | 60 | 43 | 47.7 | 16 | 239 | ..... |
| 8 | 29.034 | 56 | 40 | 46.0 | 32 | 346 | .06 |
| 9 | 28.885 | 48 | 34 | 40.7 | 28 | 449 | 1.29 |
| 10 | 29.146 | 34 | 24 | 28.7 | 32 | 448 | —* |
| 11 | 29.186 | 39 | 22 | 28.3 | 16 | 238 | ..... |
| 12 | 29.130 | 44 | 29 | 37.3 | 10 | 148 | ..... |
| 13 | 29.111 | 45 | 34 | 40.0 | 11 | 143 | ..... |
| 14 | 29.155 | 48 | 34 | 39.0 | 15 | 175 | ..... |
| 15 | 29.125 | 55 | 33 | 43.0 | 9 | 142 | ..... |
| 16 | 29.175 | 58 | 37 | 46.0 | 12 | 168 | ..... |
| 17 | 29.126 | 65 | 41 | 52.0 | 15 | 235 | ..... |
| 18 | 28.709 | 58 | 45 | 49.0 | 30 | 297 | 1.35 |
| 19 | 28.415 | 50 | 39 | 44.0 | 35 | 490 | .09 |
| 20 | 28.800 | 53 | 33 | 41.7 | 22 | 276 | ..... |
| 21 | 28.970 | 54 | 36 | 42.7 | 20 | 275 | ..... |
| 22 | 28.878 | 44 | 39 | 40.7 | 30 | 477 | .07 |
| 23 | 29.026 | 51 | 37 | 42.3 | 16 | 384 | ..... |
| 24 | 29.211 | 53 | 33 | 42.7 | 20 | 265 | ..... |
| 25 | 29.103 | 57 | 37 | 46.0 | 20 | 266 | ..... |
| 26 | 28.939 | 56 | 40 | 47.7 | 18 | 236 | .19 |
| 27 | 28.949 | 65 | 43 | 53.0 | 30 | 313 | —* |
| 28 | 29.099 | 53 | 43 | 44.3 | 20 | 282 | ..... |
| 29 | 29.134 | 56 | 40 | 44.3 | 25 | 256 | ..... |
| 30 | 29.075 | 57 | 35 | 45.7 | 16 | 221 | ..... |
| Means. | 29.009 | 55.2 | 37.1 | 44.9 | Sums | 8,613 | 4.21 |

Highest barometer, 29.227 in.; lowest, 28.197 in. Highest temperature, 78°; lowest, 22°. Maximum velocity of wind, 44 miles. Prevailing winds, E., N. E., W. No. of cloudy days, 10; No. of fair days, 16; No. of clear days, 4. Range of thermometer, 56°; range of barometer, 1.030 in.

Memoranda: No. times wind blew from N., 6; N. E., 17; E., 27; S. E., 3; S., 4; S. W., 11; W., 12; N. W., 10. (Observations once in 8 hours.)

* Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF MAY, 1882.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind. | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ° | ° | Miles. | | Inch's |
| 1 | 29.043 | 53 | 38 | 44.3 | 21 | 367 | ——* |
| 2 | 29.253 | 56 | 33 | 44.0 | 16 | 198 | ..... |
| 3 | 28.960 | 57 | 43 | 50.7 | 17 | 267 | .03 |
| 4 | 28.789 | 58 | 49 | 53.0 | 18 | 189 | .37 |
| 5 | 28.877 | 52 | 40 | 45.0 | 25 | 410 | .02 |
| 6 | 29.089 | 56 | 37 | 44.0 | 20 | 350 | ..... |
| 7 | 29.064 | 60 | 37 | 50.0 | 20 | 333 | ..... |
| 8 | 28.802 | 78 | 52 | 64.7 | 25 | 350 | .08 |
| 9 | 28.700 | 75 | 62 | 66.7 | 20 | 311 | ..... |
| 10 | 28.625 | 69 | 44 | 53.3 | 20 | 254 | .69 |
| 11 | 28.788 | 44 | 39 | 40.0 | 24 | 427 | .26 |
| 12 | 28.868 | 44 | 39 | 41.3 | 25 | 477 | .22 |
| 13 | 28.942 | 57 | 41 | 48.3 | 25 | 414 | .01 |
| 14 | 28.990 | 63 | 44 | 50.3 | 20 | 326 | ..... |
| 15 | 29.129 | 57 | 37 | 47.0 | 18 | 285 | ..... |
| 16 | 29.243 | 67 | 41 | 52.3 | 5 | 74 | ..... |
| 17 | 29.274 | 74 | 46 | 59.0 | 11 | 120 | ..... |
| 18 | 29.219 | 75 | 51 | 62.0 | 20 | 203 | ..... |
| 19 | 29.016 | 68 | 57 | 62.3 | 18 | 235 | ——* |
| 20 | 28.875 | 73 | 45 | 57.3 | 30 | 291 | .42 |
| 21 | 28.965 | 50 | 43 | 45.0 | 18 | 274 | ..... |
| 22 | 29.100 | 51 | 38 | 42.3 | 22 | 326 | ..... |
| 23 | 29.218 | 59 | 35 | 44 7 | 14 | 183 | ..... |
| 24 | 29.129 | 56 | 44 | 48.7 | 12 | 182 | ..... |
| 25 | 29.038 | 68 | 43 | 55.3 | 18 | 199 | ..... |
| 26 | 28.917 | 66 | 52 | 57.3 | 10 | 134 | .09 |
| 27 | 28.878 | 56 | 45 | 49.3 | 20 | 281 | ..... |
| 28 | 29.003 | 66 | 41 | 52.0 | 21 | 278 | ..... |
| 29 | 29.032 | 71 | 44 | 58.0 | 11 | 154 | ..... |
| 30 | 28.747 | 67 | 50 | 59.7 | 28 | 222 | .25 |
| 31 | 28.683 | 62 | 50 | 54.7 | 26 | 293 | .45 |
| Means. | 28.976 | 61.6 | 43.9 | 51.7 | Sums. | 8346 | 2.89 |

Highest barometer, 29.325 in.; lowest, 28.548 in.; highest temperature, 78°; lowest, 33°; maximum velocity of wind, 30 miles; prevailing winds: N. E., S.; No. of cloudy days, 13; No. of fair days, 13; No. of clear days, 5; range of thermometer, 45°; range of barometer, 0.777 in.

Memoranda: No. times wind blew from N., 9; E., 13; S., 18; W., 4; N. E., 22; S. E., 8; S. W., 10; N. W., 9. (Observations once in eight hours.)

*Precipitation too small to be measured.

METEOROLOGICAL RECORD FOR THE MONTH OF JUNE, 1882.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind. | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ° | ° | Miles. | | Inch's |
| 1 | 28.783 | 68 | 46 | 56.3 | 17 | 171 | —* |
| 2 | 28.771 | 60 | 53 | 54.0 | 14 | 182 | .04 |
| 3 | 28.779 | 52 | 42 | 45.7 | 26 | 403 | 1.26 |
| 4 | 28.873 | 57 | 44 | 50.3 | 18 | 287 | .04 |
| 5 | 29.036 | 73 | 45 | 59.7 | 15 | 198 | ..... |
| 6 | 29.003 | 78 | 54 | 64.3 | 16 | 277 | ..... |
| 7 | 28.850 | 79 | 58 | 67.7 | 19 | 289 | ..... |
| 8 | 28.756 | 78 | 62 | 68.7 | 15 | 197 | .25 |
| 9 | 28.817 | 80 | 54 | 67.3 | 12 | 127 | ..... |
| 10 | 28.919 | 69 | 52 | 57.0 | 20 | 265 | ..... |
| 11 | 29.107 | 71 | 45 | 58.3 | 16 | 276 | ..... |
| 12 | 29.063 | 77 | 49 | 63.0 | 15 | 169 | ..... |
| 13 | 28.973 | 77 | 53 | 66.0 | 15 | 156 | .18 |
| 14 | 28.701 | 79 | 65 | 70.0 | 22 | 275 | .10 |
| 15 | 28.812 | 82 | 63 | 71.3 | 13 | 241 | ..... |
| 16 | 28.745 | 78 | 65 | 68.0 | 12 | 154 | .56 |
| 17 | 28.574 | 83 | 66 | 69.3 | 18 | 186 | ..... |
| 18 | 28.482 | 75 | 49 | 63.7 | 28 | 418 | .31 |
| 19 | 29.047 | 67 | 47 | 55.7 | 25 | 315 | —* |
| 20 | 29.084 | 65 | 52 | 58.7 | 16 | 268 | —* |
| 21 | 29.094 | 70 | 56 | 62.3 | 13 | 170 | .11 |
| 22 | 29.013 | 87 | 61 | 70.7 | 48 | 200 | .58 |
| 23 | 29.024 | 80 | 64 | 72.0 | 12 | 127 | ..... |
| 24 | 28.879 | 81 | 65 | 71.0 | 27 | 182 | 1.49 |
| 25 | 28.936 | 79 | 67 | 70.7 | 8 | 116 | ..... |
| 26 | 29.057 | 81 | 64 | 70.7 | 8 | 118 | ..... |
| 27 | 28.988 | 78 | 66 | 70.7 | 12 | 116 | .63 |
| 28 | 28.969 | 75 | 62 | 68.0 | 13 | 113 | ..... |
| 29 | 28.895 | 80 | 60 | 70.0 | 14 | 182 | .14 |
| 30 | 28.674 | 84 | 67 | 73.7 | 16 | 252 | 2.07 |
| Means. | 28.889 | 74.8 | 56.5 | 64.5 | Sums. | 6412 | 7.76 |

Highest barometer, 29.137 in.; lowest, 28.361 in.; highest temperature, 87°; lowest, 42°; maximum velocity of wind, 48 miles; prevailing winds E., S. W., W.; No. of cloudy days, 10; No. of fair days, 13; No. of clear days, 7; range of thermometer, 45°; range of barometer, 0.776 in.

Memoranda. No. of times wind blew from N., 10; E., 21; S., 4; W., 15; N. E., 5; S. E. 9; S. W., 15; N. W.. 11. (Observations once in 8 hours.

* Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF JULY, 1882.

| Day. | Mean daily barometer | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | inches | ° | ° | ° | miles | | inches |
| 1 | 28.937 | 72 | 60 | 66.0 | 19 | 239 | ..... |
| 2 | 29.087 | 77 | 55 | 65.7 | 8 | 102 | ..... |
| 3 | 28.941 | 68 | 55 | 59.7 | 22 | 237 | .91 |
| 4 | 29.132 | 70 | 50 | 59.7 | 22 | 257 | —* |
| 5 | 29.121 | 75 | 55 | 63.0 | 7 | 93 | ..... |
| 6 | 28.963 | 71 | 60 | 64.3 | 16 | 214 | .05 |
| 7 | 28.772 | 71 | 61 | 63.0 | 16 | 212 | .33 |
| 8 | 28·916 | 78 | 63 | 68.3 | 7 | 79 | ..... |
| 9 | 28.872 | 80 | 65 | 69.7 | 16 | 202 | .83 |
| 10 | 28.816 | 78 | 57 | 66.7 | 16 | 228 | ..... |
| 11 | 28.865 | 79 | 60 | 67.3 | 20 | 280 | ..... |
| 12 | 28.838 | 70 | 58 | 62.3 | 20 | 265 | .01 |
| 13 | 28.977 | 69 | 57 | 61.7 | 18 | 194 | .04 |
| 14 | 29.122 | 78 | 50 | 64.7 | 9 | 114 | ..... |
| 15 | 29.029 | 78 | 61 | 68.7 | 20 | 274 | —* |
| 16 | 28.912 | 78 | 65 | 69.0 | 17 | 264 | ..... |
| 17 | 29.007 | 81 | 60 | 68.7 | 9 | 132 | ..... |
| 18 | 28.936 | 77 | 59 | 65.7 | 17 | 258 | ..... |
| 19 | 29.045 | 72 | 57 | 62.3 | 14 | 215 | ..... |
| 20 | 29.148 | 76 | 56 | 61.7 | 19 | 156 | —* |
| 21 | 29.210 | 80 | 55 | 64.7 | 17 | 140 | ..... |
| 22 | 29.257 | 83 | 61 | 70.7 | 6 | 73 | ..... |
| 23 | 29.190 | 84 | 64 | 72.3 | 11 | 114 | ..... |
| 24 | 29.039 | 85 | 64 | 73.0 | 15 | 171 | ..... |
| 24 | 29.018 | 86 | 69 | 76.0 | 12 | 178 | ..... |
| 26 | 29.018 | 87 | 67 | 75.7 | 12 | 170 | ..... |
| 27 | 28.949 | 84 | 72 | 75.7 | 15 | 202 | .01 |
| 28 | 29.068 | 78 | 64 | 68.3 | 12 | 157 | ..... |
| 29 | 29.173 | 75 | 54 | 64.0 | 12 | 197 | ..... |
| 30 | 29.084 | 70 | 58 | 64.0 | 15 | 224 | .12 |
| 31 | 28.985 | 71 | 62 | 67.0 | 18 | 241 | .40 |
| Means. | 29.914 | 76.7 | 60.0 | 66.8 | Sums. | 5884 | 2.70 |

Highest barometer, 29.293 in.; lowest, 28.754 in. Highest temperature, 87°; lowest, 50°. Maximum velocity of wind, 22 miles. Prevailing winds, W., N.W., S.W. No. of cloudy days, 4; No. of fair days, 20; No. of clear days, 7. Range of thermometer, 37°; range of barometer, 0.539 in.

Memoranda: No. times the wind blew from the N., 11; E., 10; S., 14; W., 16; N.E., 4; S.E., 8; S. W., 13; N.W., 17. (Observations once in 8 hours.)

*Precipitation too small to be measured.

METEOROLOGICAL RECORD FOR THE MONTH OF AUGUST, 1882.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind. | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ° | ° | Miles. | | Inch's |
| 1 | 28.970 | 77 | 65 | 66.0 | 13 | 108 | .88 |
| 2 | 28.930 | 74 | 64 | 67.3 | 14 | 206 | .33 |
| 3 | 28.911 | 68 | 63 | 65.3 | 15 | 275 | .80 |
| 4 | 28.947 | 73 | 65 | 67.7 | 12 | 212 | .07 |
| 5 | 29.018 | 80 | 66 | 71.0 | 12 | 159 | ..... |
| 6 | 29.043 | 79 | 67 | 72.7 | 6 | 74 | ..... |
| 7 | 28.919 | 85 | 68 | 74.0 | 24 | 176 | ..... |
| 8 | 28.894 | 71 | 63 | 63.7 | 23 | 378 | ..... |
| 9 | 29.002 | 61 | 55 | 57.0 | 23 | 257 | .06 |
| 10 | 29.114 | 72 | 50 | 58.3 | 11 | 185 | —* |
| 11 | 28.969 | 77 | 55 | 65.7 | 13 | 242 | ..... |
| 12 | 28.921 | 75 | 64 | 67.3 | 13 | 198 | —* |
| 13 | 28.907 | 82 | 62 | 70.7 | 16 | 223 | .01 |
| 14 | 28.778 | 87 | 66 | 73.0 | 32 | 247 | 1.30 |
| 15 | 28.852 | 81 | 63 | [illegible] | 35 | 195 | 2 20 |
| 16 | 28.975 | 74 | 60 | [illegible] | 16 | 219 | ..... |
| 17 | 29.130 | 80 | 59 | [illegible] | 13 | 95 | ..... |
| 18 | 29.145 | 82 | 64 | 72.7 | 8 | 81 | ..... |
| 10 | 29.153 | 83 | 65 | 71.3 | 11 | 141 | ..... |
| 20 | 29.220 | 85 | 67 | 73.7 | 8 | 118 | ..... |
| 21 | 29.160 | 84 | 67 | 73.3 | 13 | 158 | ..... |
| 22 | 29.045 | 82 | 68 | 75.0 | 9 | 104 | —* |
| 23 | 29.034 | 86 | 69 | 74.0 | 12 | 113 | ..... |
| 24 | 28.984 | 83 | 67 | 73.3 | 17 | 121 | .01 |
| 25 | 28.924 | 83 | 68 | 73.0 | 13 | 101 | .04 |
| 26 | 28.995 | 82 | 67 | 72.7 | 11 | 119 | ..... |
| 27 | 29.062 | 80 | 65 | 70.3 | 12 | 182 | ..... |
| 28 | 29.060 | 81 | 63 | 70.7 | 12 | 167 | ..... |
| 29 | 29.060 | 80 | 64 | 72.3 | 11 | 144 | ..... |
| 30 | 29.002 | 72 | 61 | 64.7 | 18 | 203 | 1.13 |
| 31 | 29.062 | 63 | 58 | 60.3 | 18 | 301 | .—* |
| Means. | 29.006 | 78.1 | 63.5 | 69.1 | Sums. | 5502 | 6.83 |

Highest barometer, 29.248 inches; lowest, 28.725 inches; highest temperature, 87°; lowest, 50°; maximum velocity of wind, 35 miles; prevailing winds, N., E., S. W.; No. of cloudy days, 8; No. of fair days, 20; No. of clear days, 3; range of thermometer, 37°; range of barometer, 0.513.

Memoranda: No. times wind blew from the N., 18; E., 18; S. 5; W. 7; N. E., 12; S. E., 2; S. W., 17; N. W., 14. (Observations once in eight hours.)

* Precipitation too small to be measured.

METEOROLOGICAL RECORD FOR THE MONTH OF SEPTEMBER, 1882.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind | Wind number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | inches. | ° | ° | ° | miles | | inches |
| 1 | 29.040 | 62 | 57 | 59.7 | 10 | 155 | .63 |
| 2 | 28.932 | 72 | 55 | 61.3 | 12 | 206 | .42 |
| 3 | 28.988 | 71 | 58 | 62.0 | 18 | 240 | .23 |
| 4 | 29.198 | 76 | 57 | 64.3 | 12 | 167 | ..... |
| 5 | 29.229 | 80 | 60 | 67.3 | 6 | 104 | ..... |
| 6 | 29.094 | 77 | 61 | 67.7 | 15 | 186 | ..... |
| 7 | 29.007 | 78 | 63 | 68.3 | 12 | 109 | ..... |
| 8 | 29.101 | 74 | 57 | 63.0 | 8 | 127 | ..... |
| 9 | 29.120 | 79 | 58 | 65.0 | 10 | 59 | .53 |
| 10 | 29.123 | 69 | 56 | 60.7 | 12 | 171 | ..... |
| 11 | 29.092 | 77 | 49 | 59.7 | 12 | 205 | ..... |
| 12 | 28.985 | 73 | 55 | 64.0 | 15 | 190 | ..... |
| 13 | 28 788 | 80 | 62 | 68.0 | 10 | 142 | ..... |
| 14 | 28.926 | 78 | 65 | 69.0 | 18 | 270 | ..... |
| 15 | 29.107 | 80 | 55 | 66.0 | 9 | 115 | ..... |
| 16 | 29.043 | 78 | 61 | 68.3 | 8 | 122 | ..... |
| 17 | 28.864 | 83 | 66 | 72.7 | 12 | 191 | ..... |
| 18 | 28.756 | 85 | 69 | 74.3 | 20 | 226 | —* |
| 19 | 28.936 | 73 | 56 | 62.7 | 17 | 260 | ..... |
| 20 | 29.209 | 56 | 48 | 50.3 | 17 | 245 | ..... |
| 21 | 29.207 | 57 | 44 | 49.0 | 13 | 189 | ..... |
| 22 | 29.064 | 64 | 43 | 52.7 | 23 | 248 | ..... |
| 23 | 29.224 | 62 | 44 | 51.0 | 12 | 196 | ..... |
| 24 | 29.324 | 64 | 45 | 52.7 | 12 | 105 | .06 |
| 25 | 29.415 | 63 | 50 | 55.0 | 12 | 162 | ..... |
| 26 | 29.343 | 66 | 45 | 53.0 | 12 | 159 | ..... |
| 27 | 29.099 | 63 | 47 | 55.0 | 16 | 209 | ..... |
| 28 | 28.983 | 69 | 53 | 60.0 | 13 | 207 | ..... |
| 29 | 29.049 | 66 | 58 | 60.3 | 13 | 209 | .04 |
| 30 | 29.192 | 67 | 56 | 60.3 | 7 | 92 | ..... |
| Means. | 29.081 | 71.4 | 55.1 | 61.4 | Sums | 5,266 | 1.91 |

Highest barometer, 29.448 in.; lowest, 28.709 in. Highest temperature, 85°; lowest, 43°. Maximum velocity of wind, 23 miles. Prevailing winds, E., W., S. No. of cloudy days, 3; No. of fair days, 19; No. of clear days, 8. Range of thermometer, 42°; Range of barometer, 0.739 inches.

Memoranda: No. of times blew from the N., 7; N. E., 11; E., 22; S. E., 10; S., 13; S. W., 6; W., 15; N. W., 6. (Observations once in 8 hours.)

*Precipitation too small to be measured.

METEOROLOGICAL RECORD FOR THE MONTH OF OCTOBER, 1882.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | inches | ° | ° | ° | miles | | inches |
| 1 | 29.245 | 65 | 57 | 60.0 | 7 | 105 | —* |
| 2 | 29.211 | 70 | 57 | 62.7 | 11 | 186 | ..... |
| 3 | 29.204 | 71 | 58 | 62.3 | 8 | 188 | ..... |
| 4 | 29.158 | 72 | 57 | 63.7 | 10 | 119 | ..... |
| 5 | 29.160 | 78 | 61 | 67.3 | 14 | 99 | ..... |
| 6 | 29.086 | 78 | 63 | 69.3 | 16 | 162 | ..... |
| 7 | 28.889 | 68 | 63 | 65.3 | 18 | 179 | 1.56 |
| 8 | 28.648 | 68 | 56 | 61.7 | 21 | 255 | .75 |
| 9 | 28.980 | 64 | 48 | 52.3 | 13 | 302 | ..... |
| 10 | 29.028 | 50 | 43 | 46.3 | 18 | 156 | .35 |
| 11 | 28.944 | 57 | 41 | 50.0 | 24 | 264 | ..... |
| 12 | 28.672 | 67 | 52 | 49.0 | 22 | 434 | .66 |
| 13 | 28.847 | 66 | 52 | 56.3 | 20 | 249 | ..... |
| 14 | 28.973 | 71 | 51 | 59.7 | 20 | 271 | ..... |
| 15 | 28.931 | 69 | 51 | 59.3 | 20 | 288 | ..... |
| 16 | 28.861 | 61 | 45 | 50.3 | 15 | 199 | .12 |
| 17 | 29.002 | 62 | 42 | 50.7 | 8 | 142 | ..... |
| 18 | 29.183 | 53 | 40 | 45.7 | 16 | 261 | ..... |
| 19 | 29.217 | 58 | 35 | 45.0 | 12 | 135 | ..... |
| 20 | 29.118 | 53 | 42 | 51.7 | 11 | 154 | ..... |
| 21 | 28.966 | 64 | 46 | 55.0 | 20 | 240 | ..... |
| 22 | 28.976 | 62 | 46 | 50.0 | 25 | 271 | ..... |
| 23 | 29.011 | 58 | 43 | 48.3 | 8 | 116 | ..... |
| 24 | 28.935 | 65 | 43 | 53.3 | 16 | 167 | ..... |
| 25 | 28.791 | 63 | 48 | 53.7 | 22 | 137 | ..... |
| 26 | 29.112 | 53 | 39 | 44.7 | 14 | 152 | ..... |
| 27 | 29.031 | 59 | 37 | 47.7 | 10 | 135 | ..... |
| 28 | 28.779 | 54 | 43 | 47.7 | 15 | 217 | .15 |
| 29 | 28.803 | 49 | 41 | 45.3 | 15 | 243 | ..... |
| 30 | 28.572 | 63 | 47 | 56.0 | 32 | 276 | .55 |
| 31 | 28.906 | 62 | 43 | 47.7 | 23 | 245 | ..... |
| Means. | 28.975 | 64.9 | 49.4 | 54.5 | Sums | 6,456 | 4.14 |

Highest barometer, 29.281 in.; lowest, 28.419 in. Highest temperature, 78°; lowest, 35°. Maximum velocity of wind, 32 miles; Prevailing winds, S., N. W., E., S. E. No. of cloudy days, 7; No. of fair days, 15; No. of clear days, 9. Range of thermometer, 43°; range of barometer, 0.862 in.

Memoranda: No. times wind blew from N., 4; N. E., 3; E., 14; S. E., 13; S., 25; S. W., 6; W., 10; N. W., 18. (Observations once in 8 hours.)

* Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF NOVEMBER, 1882.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind. | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ″ | ° | Miles. | | Inch's |
| 1 | 29.285 | 56 | 38 | 44.3 | 13 | 160 | ..... |
| 2 | 29.535 | 49 | 30 | 39.3 | 13 | 353 | ..... |
| 3 | 29.326 | 54 | 37 | 44.7 | 9 | 102 | ..... |
| 4 | 29.198 | 55 | 36 | 45.7 | 22 | 252 | ..... |
| 5 | 28.913 | 51 | 42 | 45.7 | 22 | 380 | 1.07 |
| 6 | 28.890 | 49 | 46 | 46.3 | 11 | 131 | .10 |
| 7 | 29.095 | 58 | 44 | 50.0 | 11 | 143 | ..... |
| 8 | 29.128 | 53 | 41 | 45.3 | 14 | 163 | ..... |
| 9 | 28.951 | 50 | 40 | 45.7 | 6 | 85 | ..... |
| 10 | 28.840 | 61 | 48 | 56.3 | 20 | 215 | .07 |
| 11 | 28.720 | 66 | 49 | 56.7 | 24 | 303 | .61 |
| 12 | 28.917 | 49 | 25 | 28.7 | 23 | 349 | ..... |
| 13 | 29.008 | 31 | 18 | 25.0 | 22 | 342 | —* |
| 14 | 28.826 | 41 | 27 | 35.7 | 21 | 279 | ..... |
| 15 | 29.066 | 47 | 34 | 39.3 | 19 | 245 | ..... |
| 16 | 29.096 | 42 | 33 | 37.7 | 16 | 192 | .38 |
| 17 | 29.316 | 42 | 34 | 37.7 | 23 | 314 | .05 |
| 18 | 29.281 | 43 | 37 | 38.7 | 12 | 139 | ..... |
| 19 | 29.247 | 44 | 30 | 37.3 | 7 | 101 | ..... |
| 20 | 29.078 | 44 | 35 | 39.7 | 12 | 129 | ..... |
| 21 | 28.965 | 40 | 31 | 35.3 | 16 | 267 | ..... |
| 22 | 28.877 | 44 | 33 | 39.3 | 18 | 175 | ..... |
| 23 | 28.901 | 40 | 23 | 28.3 | 28 | 462 | .18 |
| 24 | 29.287 | 30 | 19 | 24.0 | 25 | 301 | ..... |
| 25 | 29.161 | 44 | 26 | 35.7 | 16 | 195 | ..... |
| 26 | 29.036 | 37 | 25 | 29.7 | 21 | 334 | —* |
| 27 | 29.232 | 36 | 17 | 28.0 | 17 | 180 | ..... |
| 28 | 29.122 | 35 | 25 | 30.3 | 18 | 159 | .16 |
| 29 | 29.278 | 32 | 21 | 26.0 | 20 | 324 | —* |
| 30 | 29.073 | 36 | 26 | 31.3 | 14 | 220 | ..... |
| Means. | 29.088 | 45.3 | 32.3 | 38.3 | Sums. | 6894 | 2.62 |

Highest barometer, 29.538 inches; lowest, 28.650 inches; highest temperature, 66°; lowest, 17°; maximum velocity of wind, 28 miles; prevailing winds, N. W., W.; No. of cloudy days, 11; No. of fair days, 15; No. of clear days, 4; range of thermometer, 49°; range of barometer, 0.938 inches.

Memoranda: No. of times wind blew from the N., 7; E., 10; S., 12; W., 14; N. E, 8; S. E., 12; S. W., 10; N. W., 17. (Observations once in eight hours.)

* Precipitation too small to be measured.

METEOROLOGICAL RECORD FOR THE MONTH OF DECEMBER, 1882.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind. | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ° | ° | Miles. | | Inch's |
| 1 | 28.877 | 43 | 29 | 35.0 | 13 | 144 | |
| 2 | 29.273 | 33 | 17 | 20.7 | 28 | 416 | .05 |
| 3 | 28.992 | 34 | 18 | 28.7 | 21 | 251 | .15 |
| 4 | 28.659 | 34 | 23 | 26.7 | 38 | 462 | .01 |
| 5 | 28.947 | 27 | 16 | 21.7 | 23 | 225 | |
| 6 | 29.192 | 16 | 0 | 5.3 | 36 | 370 | .09 |
| 7 | 29.546 | 0 | —13 | —8.3 | 35 | 473 | |
| 8 | 29.295 | 12 | — 8 | 5.3 | 16 | 210 | |
| 9 | 28.812 | 24 | 12 | 19.0 | 14 | 211 | .06 |
| 10 | 28.832 | 22 | 12 | 15.7 | 16 | 233 | .05 |
| 11 | 28.999 | 27 | 7 | 19.0 | 14 | 169 | .01 |
| 12 | 28.756 | 42 | 26 | 36.3 | 20 | 248 | |
| 13 | 28.885 | 32 | 5 | 14.0 | 23 | 327 | |
| 14 | 29.031 | 20 | 8 | 12.7 | 22 | 304 | .03 |
| 15 | 29.200 | 8 | — 4 | 2.7 | 20 | 398 | |
| 16 | 29.041 | 16 | 0 | 9.7 | 16 | 210 | .02 |
| 17 | 28.882 | 24 | 11 | 19.0 | 8 | 116 | .18 |
| 18 | 29.092 | 31 | 18 | 25.3 | 15 | 177 | |
| 19 | 28.883 | 37 | 24 | 33.7 | 19 | 260 | .08 |
| 20 | 28.581 | 39 | 33 | 35.3 | 14 | 255 | .80 |
| 21 | 28.626 | 38 | 33 | 35.0 | 10 | 137 | .19 |
| 22 | 28.770 | 38 | 33 | 33.7 | 10 | 136 | —* |
| 23 | 28.855 | 32 | 25 | 26.7 | 10 | 173 | —* |
| 24 | 29.086 | 32 | 19 | 25.7 | 8 | 87 | |
| 25 | 29.140 | 36 | 23 | 31.7 | 10 | 135 | .20 |
| 26 | 29.245 | 37 | 30 | 33.7 | 10 | 97 | .03 |
| 27 | 29.288 | 36 | 23 | 26.0 | 10 | 86 | .02 |
| 28 | 29.270 | 37 | 23 | 28.7 | 12 | 83 | |
| 29 | 29.180 | 28 | 20 | 24.3 | 13 | 178 | |
| 30 | 29.236 | 25 | 19 | 21.7 | 8 | 93 | .05 |
| 31 | 29.311 | 22 | 4 | 8.7 | 15 | 189 | .01 |
| Means. | 39.025 | 28.5 | 15.7 | 21.7 | Sums. | 6853 | 2.03 |

Highest barometer, 29.577 in.; lowest, 28.487 in.; Highest temperature, 43°; lowest, —13°; Maximum velocity of wind, 38 miles; prevailing winds, N. W., W.; No. of cloudy days, 15; No. of fair days, 12; No. of clear days, 4; range of thermometer, 56°; range of barometer, 1.090 in.

Memoranda. No. times wind blew from the N., 6; E., 7; S., 4; W., 23; N. E., 4; S. E., 15; S. W., 10; N. W., 24. (Observations taken once in 8 hours.)

* Precipitation too small to be measured.

METEOROLOGICAL SUMMARY FOR THE YEAR 1882.

| Month. | Mean monthly barometer. | Mean maximum thermometer. | Mean minimum thermometer. | Mean monthly temperature. | Maximum velocity of wind. | Wind, number miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| 1882. | Inches. | ° | ° | ° | Miles. | | Inch's |
| January.... | 29.052 | 30.8 | 13.1 | 22.4 | 38 | 7,480 | 1.33 |
| February... | 28.958 | 42.2 | 25.8 | 35.5 | 30 | 8,008 | 1.74 |
| March..... | 28.993 | 42.5 | 28.2 | 34.4 | 34 | 9,734 | 4.73 |
| April..... | 29.009 | 52.5 | 37.1 | 44.9 | 44 | 8,613 | 4.21 |
| May..... | 28.976 | 61.6 | 43.9 | 51.7 | 30 | 8,346 | 2.89 |
| June ..... | 28.889 | 74.6 | 56.5 | 64.5 | 48 | 6,412 | 7.76 |
| July ..... | 29.014 | 76.7 | 60.0 | 66.8 | 22 | 5,884 | 2.70 |
| August..... | 29.006 | 78.1 | 63.5 | 69.1 | 35 | 5,502 | 6.83 |
| September . | 29.081 | 71.4 | 55.1 | 61.4 | 23 | 5,266 | 1.91 |
| October.. .. | 28.975 | 64.9 | 49.4 | 54.5 | 32 | 6,456 | 4.14 |
| November.. | 29.088 | 45.3 | 32.3 | 38.3 | 28 | 6,894 | 2.62 |
| December .. | 29.025 | 28.5 | 15.7 | 21.7 | 38 | 6,853 | 2.03 |
| Means..... | 29.005 | 55.8 | 40.0 | 47.1 | Sums. | 85,448 | 42.89 |

No. days on which rain has fallen in quantities too small to be measured, 30.

Highest barometer, 29.679 in.; lowest, 28.197 in.; highest temperature, 87°; lowest, —13°; maximum velocity of wind, 48 miles; prevailing winds, N. W., W. E., S.; No. of cloudy days, 112; No. of fair days, 191; No. of clear days, 62; range of thermometer, 100°; range of barometer, 1.482 in.

Memoranda: No. times wind blew from the N., 95; E., 161; S., 154; W., 163; N. E., 104; S. E., 116; S, W., 129; N. W., 181. (Observations once in eight hours.)

NOTE — The observations for the year 1882 were taken at the U. S. Signal Station, Madison.

METEOROLOGICAL RECORD FOR THE MONTH OF JANUARY, 1883.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind. | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ° | ° | Miles. | | Inch's |
| 1 | 29.228 | 22 | 1 | 9.7 | 10 | 141 | ..... |
| 2 | 29.176 | 21 | —2 | 11.3 | 20 | 195 | .01 |
| 3 | 29.354 | 19 | —5 | 2.0 | 20 | 265 | ..... |
| 4 | 29.317 | 13 | —5 | 5.7 | 12 | 208 | .15 |
| 5 | 29.107 | 23 | 12 | 18.7 | 8 | 84 | .04 |
| 6 | 28.754 | 28 | 15 | 21.3 | 20 | 258 | .03 |
| 7 | 29.083 | 20 | 2 | 6.3 | 14 | 210 | ..... |
| 8 | 29.231 | 6 | — 7 | 2.0 | 19 | 212 | ..... |
| 9 | 28.793 | 18 | —12 | 7.0 | 16 | 173 | .02 |
| 10 | 28.581 | 14 | 7 | 1.7 | 25 | 283 | .19 |
| 11 | 29.133 | 18 | 8 | 11.7 | 15 | 182 | —* |
| 12 | 28.717 | 35 | 5 | 16.0 | 24 | 329 | .02 |
| 13 | 28.747 | 35 | — 1 | 29.0 | 23 | 407 | .03 |
| 14 | 29.244 | 7 | —11 | — 1.7 | 16 | 178 | ..... |
| 15 | 29.332 | 18 | — 7 | 8.7 | 5 | 61 | —* |
| 16 | 29.126 | 26 | 13 | 19.7 | 6 | 64 | .19 |
| 17 | 28.894 | 24 | 13 | 18.6 | 17 | 262 | .12 |
| 18 | 29.184 | 23 | — 2 | 14.3 | 11 | 130 | .08 |
| 19 | 29.096 | 29 | —10 | 8.0 | 20 | 311 | .04 |
| 20 | 28.874 | —5 | —17 | —11.3 | 23 | 265 | ..... |
| 21 | 29.079 | —12 | —23 | —18.0 | 20 | 268 | ..... |
| 22 | 29.341 | —12 | —23 | —17.0 | 16 | 220 | ..... |
| 23 | 29.401 | 0 | —21 | —12.0 | 13 | 194 | ..... |
| 24 | 29.162 | 12 | — 2 | 5.3 | 16 | 228 | .03 |
| 25 | 29.371 | 7 | —10 | — 0.7 | 11 | 144 | ..... |
| 26 | 28.957 | 28 | 0 | 17.0 | 15 | 155 | .02 |
| 27 | 28.980 | 28 | 18 | 20.7 | 16 | 166 | ..... |
| 28 | 28.952 | 32 | 12 | 22.3 | 10 | 120 | ..... |
| 29 | 28.776 | 30 | 9 | 19.3 | 8 | 87 | —* |
| 30 | 28.409 | 31 | 15 | 24.0 | 24 | 355 | .04 |
| 31 | 28.947 | 15 | —9 | 1.7 | 22 | 411 | ..... |
| Means. | 29.043 | 18.3 | —4.6 | 8.5 | Sums. | 6666 | 1.01 |

Highest barometer, 29.473 in.; lowest, 28.352 in.; highest temperature, 35°; lowest —23°; maximum velocity of wind, 25 miles; prevailing winds, N. W., W., S. W.; No. of cloudy days, 6; No. of fair days, 20; No. of clear days, 5; range of thermometer, 58°; range of barometer, 1.121 in.

Memoranda. No. of times wind blew from N., 6; E., 7; S., 6; W.,21; N. E., 3; S. E., 7; S. W., 17; N. W., 26. (Observed every eight hours.)

* Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF FEBRUARY, 1883.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind. | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ° | ° | Miles. | | Inch's |
| 1 | 29.479 | 0 | −17 | −7.7 | 14 | 191 | ..... |
| 2 | 29.365 | 2 | − 9 | −1.3 | 23 | 297 | .13 |
| 3 | 29.153 | 8 | + 2 | 6.0 | 22 | 413 | .09 |
| 4 | 29.462 | 7 | + 8 | −3.3 | 15 | 218 | ——* |
| 5 | 29.422 | 14 | −14 | −0.7 | 14 | 180 | ..... |
| 6 | 28.964 | 19 | − 1 | 11.0 | 14 | 195 | .16 |
| 7 | 29.015 | 17 | + 5 | 9.0 | 16 | 247 | .10 |
| 8 | 29.166 | 27 | 3 | 15.0 | 15 | 246 | ..... |
| 9 | 29.456 | 19 | 6 | 10.0 | 16 | 218 | ..... |
| 10 | 29.125 | 23 | − 3 | 13.3 | 12 | 152 | ——* |
| 11 | 28.901 | 29 | 15 | 21.3 | 18 | 222 | ——* |
| 12 | 29.396 | 29 | 4 | 15.3 | 10 | 59 | ..... |
| 13 | 29.176 | 36 | 5 | 24.0 | 5 | 12 | ..... |
| 14 | 28.632 | 37 | 30 | 34.0 | 16 | 121 | .07 |
| 15 | 28.712 | 38 | 33 | 36.0 | 17 | 117 | .07 |
| 16 | 28.631 | 49 | 12 | 34.0 | 28 | 306 | .78 |
| 17 | 29.514 | 14 | 0 | 7.0 | 25 | 358 | ..... |
| 18 | 29.487 | 28 | 1 | 16.7 | 20 | 248 | ..... |
| 19 | 29.359 | 32 | 18 | 24.7 | 14 | 140 | ..... |
| 20 | 29.112 | 33 | 19 | 27.0 | 24 | 334 | ..... |
| 21 | 29.160 | 31 | 11 | 21.0 | 16 | 222 | .01 |
| 22 | 29.065 | 30 | 18 | 20.7 | 12 | 131 | .10 |
| 23 | 29.232 | 31 | 11 | 24.0 | 18 | 207 | ——* |
| 24 | 28.803 | 33 | 24 | 28.7 | 17 | 259 | .13 |
| 25 | 29.100 | 27 | 12 | 17.0 | 20 | 366 | ——* |
| 26 | 29.455 | 17 | 7 | 10.7 | 21 | 292 | ..... |
| 27 | 29.159 | 41 | 8 | 27.3 | 20 | 160 | ——* |
| 28 | 29.226 | 47 | 27 | 35.7 | 15 | 201 | ..... |
| Means. | 29.169 | 25.6 | 7.8 | 17.0 | Sums.. | 6112 | 1.64 |

Highest barometer, 29.608 in.; lowest, 28.494 in. Highest temperature, 49°; lowest, —17°. Maximum velocity of wind, 28 miles. Prevailing winds, W., N. W., S. W. No. of cloudy days, 7; No. of fair days, 11; No. of clear days, 10. Range of thermometer, 66°; range of barometer, 1.114 in.

Memoranda: No. times the wind blew from the N., 6; E., 6; S., 10; W., 20; N. E., 5; S, E., 9; S. W., 12; N. W., 16. (Observations once in eight hours.)

* Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF MARCH, 1883.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind. | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ° | ° | Miles. | | Incn's |
| 1 | 29.000 | 52 | 35 | 41.7 | 16 | 235 | ..... |
| 2 | 29.318 | 39 | 28 | 31.7 | 16 | 251 | ..... |
| 3 | 29.337 | 33 | 19 | 26.0 | 16 | 283 | ..... |
| 4 | 29.321 | 29 | 23 | 25.3 | 17 | 193 | ..... |
| 5 | 29.118 | 33 | 18 | 16.7 | 15 | 204 | .03 |
| 6 | 28.841 | 31 | 15 | 24.3 | 30 | 343 | .04 |
| 7 | 29.431 | 20 | 1 | 8.0 | 27 | 241 | ..... |
| 8 | 29.144 | 41 | 9 | 26.7 | 16 | 198 | ..... |
| 9 | 28.633 | 46 | 28 | 35.7 | 28 | 331 | ..... |
| 10 | 28.579 | 30 | 21 | 25.0 | 28 | 454 | .02 |
| 11 | 29.070 | 28 | 18 | 22.0 | 17 | 318 | ..... |
| 12 | 28.940 | 44 | 17 | 31.3 | 22 | 316 | ..... |
| 13 | 28.953 | 49 | 28 | 26.0 | 12 | 193 | ..... |
| 14 | 28.756 | 53 | 32 | 40.0 | 29 | 365 | ..... |
| 15 | 29.121 | 32 | 15 | 20.0 | 32 | 432 | —* |
| 16 | 28.936 | 31 | 16 | 25.0 | 15 | 199 | ..... |
| 17 | 28.476 | 52 | 26 | 40.0 | 28 | 309 | ..... |
| 18 | 28.828 | 47 | 9 | 20.7 | 32 | 383 | .10 |
| 19 | 28.995 | 22 | 5 | 11.0 | 18 | 273 | ..... |
| 20 | 28.934 | 25 | 7 | 16.0 | 10 | 117 | ..... |
| 21 | 29.067 | 32 | 9 | 20.7 | 8 | 92 | ..... |
| 22 | 28.762 | 37 | 24 | 28.3 | 32 | 317 | —* |
| 23 | 29.050 | 35 | 15 | 27.0 | 22 | 280 | ..... |
| 24 | 29.068 | 46 | 23 | 34.0 | 15 | 201 | ..... |
| 25 | 29.022 | 40 | 33 | 34.0 | 12 | 134 | .03 |
| 26 | 29.091 | 33 | 20 | 26.7 | 15 | 224 | .08 |
| 27 | 29.085 | 31 | 23 | 26.0 | 9 | 132 | .02 |
| 28 | 29.055 | 32 | 21 | 26.7 | 6 | 42 | —* |
| 29 | 28.930 | 39 | 20 | 28.3 | 6 | 76 | ..... |
| 30 | 28.940 | 41 | 25 | 30.3 | 15 | 190 | ..... |
| 31 | 29.064 | 35 | 25 | 28.7 | 18 | 278 | ..... |
| Means. | 28.995 | 36.7 | 19.6 | 27.1 | Sums. | 7606 | 0.32 |

Highest barometer, 29.486 inches; lowest, 28.332 inches; highest temperature, 53°; lowest, +1°; maximum velocity of wind, 32 miles; prevailing winds, N. W., N., W.; No. of cloudy days, 9; No. of fair days, 15; No. of clear days, 7; range of thermometer, 52°; range of barometer, 1.154 inches.

Memoranda: No. of times wind blew from the N. 17; N. E. 12; E. 1; S. E. 5; S. 7; W. 13; N. W., 28; S. W., 10. (Observed every eight hours.)

* Precipitation too small to measure. (N. B.— No observations in April.)

METEOROLOGICAL RECORD FOR THE MONTH OF MAY, 1883.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind. | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ° | ° | Miles. | ..... | Inch's |
| 1 | 28.975 | ..... | ..... | 55.0 | ..... | ..... | .10 |
| 2 | 28.983 | ..... | ..... | 42.0 | ..... | ..... | 1.00 |
| 3 | 28.969 | ..... | ..... | 39.7 | ..... | ..... | .13 |
| 4 | 29.022 | ..... | ..... | 40.5 | ..... | ..... | .08 |
| 5 | 29.057 | ..... | ..... | 48.3 | ..... | ..... | ..... |
| 6 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 7 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 8 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 9 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 10 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 11 | 29.125 | 53 | 36 | 46.0 | ..... | ..... | ..... |
| 12 | 29.106 | 55 | 39 | 47.7 | ..... | ..... | ..... |
| 13 | 28.995 | 50 | 36 | 42.3 | ..... | ..... | .80 |
| 14 | 28.571 | 45 | 40 | 41.3 | ..... | ..... | 1.70 |
| 15 | 28.934 | 57 | 37 | 52.0 | ..... | ..... | ..... |
| 16 | 29.095 | 66 | 41 | 57.3 | ..... | ..... | ..... |
| 17 | 28.936 | 73 | 47 | 55.0 | ..... | ..... | .20 |
| 18 | 28.493 | 78 | 52 | 68.5 | ..... | ..... | .32 |
| 19 | 28.583 | 89 | 59 | 63.3 | ..... | ..... | ..... |
| 20 | 28.770 | 66 | 46 | 41.5 | ..... | ..... | ..... |
| 21 | 28.938 | 49 | 33 | 41.0 | ..... | ..... | ..... |
| 22 | 29.022 | 52 | 33 | 48.0 | ..... | ..... | ..... |
| 23 | 28.977 | 65 | 36 | 58 5 | ..... | ..... | ..... |
| 24 | 28.793 | 70 | 49 | 61.7 | ..... | ..... | ..... |
| 25 | 28.753 | 69 | 52 | 54.7 | ..... | ..... | 1.80 |
| 26 | 28.769 | 69 | 47 | 57.5 | ..... | ..... | ..... |
| 27 | 28.698 | 68 | 49 | 54.3 | ..... | ..... | .05 |
| 28 | 28.662 | 66 | 46 | 55.0 | ..... | ..... | ..... |
| 29 | 28.858 | 64 | 47 | 56.3 | ..... | ..... | ..... |
| 30 | 28.809 | 65 | 48 | 55.3 | ..... | ..... | .80 |
| 31 | 29.065 | 61 | 44 | 55.7 | ..... | ..... | ..... |
| Means. | 28.883 | 63.5 | 43.7 | 51.5 | Sums. | | 6.98 |

Highest barometer, 29.181 in.; lowest, 28.439 in.; highest temperature, 78°; lowest, 33°; prevailing winds, S. W., N. E., S; No. of cloudy days, 10; No. of fair days, 8; No. of clear days, 8; range of thermometer, 56°; range of barometer, 0.742 in.

Memoranda: No. times wind blew from N., 8; E., 7; S., 10; W., 8; N. E., 13; S. E., 8; S. W., 13; N. W., 11. (Three observations daily.)

METEOROLOGICAL RECORD FOR THE MONTH OF JUNE, 1883.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind. | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ° | ° | Miles. | | Inch's |
| 1 | 29.129 | 69 | 47 | 62.0 | ..... | ..... | ..... |
| 2 | 28.925 | 74 | 54 | 63.0 | ..... | ..... | .95 |
| 3 | 28.999 | 72 | 58 | 59.0 | ..... | ..... | 2.40 |
| 4 | 29.057 | 68 | 50 | 62.5 | ..... | ..... | ..... |
| 5 | 28.874 | 75 | 55 | 69.0 | ..... | ..... | .35 |
| 6 | 28.851 | 75 | 59 | 65.7 | ..... | ..... | .08 |
| 7 | 28.824 | 75 | 56 | 66.0 | ..... | ..... | ..... |
| 8 | 28.810 | 75 | 55 | 60.7 | ..... | ..... | .65 |
| 9 | 28.715 | 69 | 54 | 59.5 | ..... | ..... | .60 |
| 10 | 28.723 | 68 | 53 | 56.3 | ..... | ..... | ..... |
| 11 | 28.672 | 71 | 51 | 65.3 | ..... | ..... | .09 |
| 12 | 28.651 | 73 | 58 | 64.3 | ..... | ..... | .40 |
| 13 | 28.998 | 73 | 51 | 58.0 | ..... | ..... | ..... |
| 14 | 29.062 | 69 | 50 | 62.0 | ..... | ..... | ..... |
| 15 | 28.891 | 73 | 53 | 65.3 | ..... | ..... | ..... |
| 16 | 28.846 | 83 | 57 | 74.7 | ..... | ..... | .80 |
| 17 | 28.735 | 71 | 62 | 70.7 | ..... | ..... | —* |
| 18 | 28.681 | 74 | 63 | 68.3 | ..... | ..... | .80 |
| 19 | 28.783 | 76 | 61 | 65.3 | ..... | ..... | ..... |
| 20 | 28.835 | 74 | 57 | 66.7 | ..... | ..... | —* |
| 21 | 28.718 | 74 | 61 | 68.0 | ..... | ..... | .30 |
| 22 | 28.988 | 77 | 57 | 70.5 | ..... | ..... | ..... |
| 23 | 28.962 | 80 | 61 | 72.0 | ..... | ..... | .15 |
| 24 | 28.893 | 80 | 63 | 69.5 | ..... | ..... | ..... |
| 25 | 28.930 | 75 | 53 | 57.5 | ..... | ..... | ..... |
| 26 | 28.921 | 70 | 53 | 55.3 | ..... | ..... | ..... |
| 27 | 28.933 | 73 | 56 | 65.0 | ..... | ..... | —* |
| 28 | 28.888 | 74 | 58 | 68.3 | ..... | ..... | ..... |
| 29 | 28.831 | 86 | 52 | 74.3 | ..... | ..... | ..... |
| 30 | 29.034 | 83 | 60 | 70.3 | ..... | ..... | ..... |
| Means. | 28.872 | 74.5 | 55.9 | 65.2 | Sums. | | 7.57 |

Highest barometer, 29.195 in.; lowest, 28.629 in.; highest temperature, 86°; lowest, 47°; prevailing winds, N., S., S. W.; No. of cloudy days, 12; No. of fair days, 11; No. of clear days, 7; range of thermometer, 39°; range of barometer, 0.566 in.

Memoranda: No. of times wind blew from N., 19; N. E., 5; E., 3; S. E., 8; S., 17; S. W., 18; W., 9; N. W., 11. (Three observations daily.)

* Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF JULY, 1883.

| Day. | Mean daily barometer | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches | ° | ° | ° | Miles | | Inch's |
| 1 | 28.925 | 83 | 60 | 75.3 | ..... | ..... | ..... |
| 2 | 28.887 | 89 | 65 | 80.7 | ..... | ..... | ..... |
| 3 | 28.828 | 89 | 69 | 81.3 | ..... | ..... | ..... |
| 4 | 28.887 | 88 | 61 | 74.5 | ..... | ..... | .88 |
| 5 | 28.979 | 88 | 62 | 75.0 | ..... | ..... | ..... |
| 6 | 28.865 | 84 | 68 | 76.3 | ..... | ..... | ..... |
| 7 | 28.922 | 83 | 59 | 60.7 | ..... | ..... | .90 |
| 8 | 29.080 | 65 | 52 | 60.5 | ..... | ..... | ..... |
| 9 | 29.057 | 72 | 53 | 66.3 | ..... | ..... | ..... |
| 10 | 28.861 | 79 | 61 | 73.7 | ..... | ..... | ..... |
| 11 | 28.776 | 81 | 67 | 74.7 | ..... | ..... | ..... |
| 12 | 28.630 | 81 | 62 | 71.7 | ..... | ..... | .35 |
| 13 | 28.763 | 79 | 57 | 68.3 | ..... | ..... | ..... |
| 14 | 28.712 | 78 | 57 | 70.5 | ..... | ..... | .02 |
| 15 | 28.813 | 80 | 58 | 70.7 | ..... | ..... | ..... |
| 16 | 28.697 | 81 | 63 | 67.0 | ..... | ..... | 1.89 |
| 17 | 29.021 | 75 | 57 | 59.7 | ..... | ..... | ..... |
| 18 | 29.233 | 69 | 52 | 64.5 | ..... | ..... | ..... |
| 19 | 29.119 | 75 | 58 | 67.7 | ..... | ..... | ..... |
| 20 | 28.852 | 76 | 60 | 69.5 | ..... | ..... | .46 |
| 21 | 28.854 | 84 | 57 | 77.3 | ..... | ..... | 2.05 |
| 22 | 29.008 | 85 | 67 | 74.7 | ..... | ..... | .30 |
| 23 | 28.930 | 83 | 66 | 68.7 | ..... | ..... | 1.16 |
| 24 | 28.918 | 75 | 63 | 70.7 | ..... | ..... | .40 |
| 25 | 28.962 | 78 | 73 | 74.0 | ..... | ..... | ..... |
| 26 | 28.925 | 83 | 67 | 75.7 | ..... | ..... | .38 |
| 27 | 29.042 | 83 | 66 | 67.3 | ..... | ..... | .10 |
| 28 | 29.007 | 69 | 57 | 65.0 | ..... | ..... | ..... |
| 29 | 29.115 | 69 | 54 | 62.7 | ..... | ..... | ..... |
| 30 | 29.170 | 69 | 54 | 62.7 | ..... | ..... | ..... |
| 31* | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Means. | 28.928 | 79.1 | 60.8 | 70.2 | Sums. | | 8.89 |

Highest barometer, 29.245 in.; lowest, 28.591 in. Highest temperature, 89°; lowest, 52°. Prevailing winds, S. W., W., S. No. of cloudy days, 5; No. of fair days, 17; No. of clear days, 8. Range of thermometer, 37°; range of barometer, 0.644 in.

Memoranda: No. times the wind blew from the N., 7; E., 4; S., 14; W., 19; N. E., 5; S. E., 7; S. W., 24; N. W., 9. (Three observations daily.)

* Instruments were being moved.

METEOROLOGICAL RECORD FOR THE MONTH OF AUGUST, 1883.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind. | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ° | ° | Miles. | | Inch's. |
| 1* | | | | | | | |
| 2 | 28.959 | 80 | 57 | 60.5 | ..... | ..... | .40 |
| 3 | 29.038 | 66 | 53 | 59.0 | ..... | ..... | ..... |
| 4 | 29.142 | 71 | 52 | 61.5 | ..... | ..... | ..... |
| 5 | 29.249 | 74 | 54 | 64.0 | ..... | ..... | ..... |
| 6 | 29.270 | 76 | 64 | 65.5 | ..... | ..... | ..... |
| 7 | 29.219 | 78 | 55 | 64.5 | ..... | ..... | ..... |
| 8 | 29.117 | 78 | 55 | 66.3 | 10 | 141 | ..... |
| 9 | 29.080 | 78 | 57 | 66.5 | 8 | 119 | ..... |
| 10 | 29.101 | 78 | 59 | 66.1 | 6 | 111 | ..... |
| 11 | 28.957 | 80 | 58 | 69.4 | 17 | 158 | ..... |
| 12 | 28.969 | 71 | ..... | 64.3 | 16 | 222 | .32 |
| 13 | 29.191 | 66 | 54 | 58.9 | 15 | 335 | ..... |
| 14 | 29.219 | 50 | 52 | 59.9 | 11 | 157 | ..... |
| 15 | 29.145 | 74 | 54 | 64.8 | 13 | 139 | ..... |
| 16 | 29.012 | 78 | 61 | 69.6 | 14 | 182 | ..... |
| 17 | 28.940 | 84 | 69 | 75.9 | 18 | 188 | .05 |
| 18 | 28.878 | 82 | 70 | 74.9 | 22 | 328 | ..... |
| 19 | 28.823 | 86 | 70 | 74.2 | 20 | 270 | .02 |
| 20 | 28.857 | 79 | 56 | 71.3 | 36 | 359 | ..... |
| 21 | 28.799 | 83 | 61 | 73.4 | 36 | 374 | ..... |
| 22 | 28.845 | 78 | 73 | 68.7 | 34 | 539 | ..... |
| 23 | 29.101 | 79 | ..... | 62.6 | 14 | 203 | ..... |
| 24 | 29.137 | 77 | 55 | 64.6 | 12 | 125 | ..... |
| 25 | 29.075 | 78 | 61 | 70.4 | 18 | 207 | ..... |
| 26 | 29.225 | 73 | 57 | 61.5 | ..... | 186 | ..... |
| 27 | 29.015 | 67 | 51 | 59.6 | ..... | 201 | 1.95 |
| 28 | 29.063 | 68 | 61 | 63.4 | ..... | 272 | ..... |
| 29 | 29.117 | 54 | 73 | 63.0 | ..... | 216 | ..... |
| 30 | 29.068 | 76 | 62 | 67.3 | ..... | 228 | ..... |
| 31 | 29.093 | 78 | 63 | 70.0 | ..... | 198 | ..... |
| Means. | 29.027 | 78.3 | 59.2 | 66.1 | Sums. | 5458 | 2.74 |

Highest barometer, 29.278 inches; lowest, 28.668 inches; highest temperature, 86°; lowest, 51°; maximum velocity of wind, 36 miles; prevailing winds, S. W., S., N. W.; No. of cloudy days, 8; No. of fair days, 11; No. of clear days, 11; range of thermometer, 35°; range of barometer, 0.590 in.

Memoranda: No. times wind blew from the N., 13; E., 3; S. 17; W. 4; N. E., 9; S. E., 9; S. W., 18; N. W., 16. (Three observations daily.)

*Instruments were being moved.

METEOROLOGICAL RECORD FOR THE MONTH OF SEPTEMBER, 1883.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind | Wind number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ° | ° | Miles | | Inch's |
| 1 | 28.975 | 77 | 64 | 71.3 | ..... | ..... | ..... |
| 2 | 29.106 | 73 | 62 | 66.0 | 28 | 191 | ..... |
| 3 | 29.156 | 71 | 56 | 62.1 | 20 | 206 | ..... |
| 4 | 29.014 | 72 | 58 | 62.7 | 24 | 336 | ..... |
| 5 | 29.255 | 67 | 47 | 57.3 | 20 | 254 | ..... |
| 6 | 29.025 | 69 | 50 | 59.6 | 20 | 211 | 0.93 |
| 7 | 28.940 | 64 | 46 | 50.3 | 36 | 321 | ..... |
| 8 | 29.337 | 53 | 38 | 45.9 | 32 | 552 | ..... |
| 9 | 29.405 | 58 | 39 | 48.1 | 16 | 172 | ..... |
| 10 | 29.291 | 64 | 39 | 43.6 | 25 | 198 | ..... |
| 11 | 29.202 | 70 | 47 | 58.4 | 16 | 181 | ..... |
| 12 | 29.105 | 73 | 47 | 59.6 | 12 | 132 | ..... |
| 13 | 28.999 | 74 | 48 | 61.9 | 12 | 118 | ..... |
| 14 | 29.048 | 79 | 54 | 67.0 | 12 | 156 | ..... |
| 15 | 28.956 | 80 | 60 | 69.9 | 16 | 174 | ..... |
| 16 | 28.967 | 72 | 58 | 61.1 | 30 | 294 | 0.54 |
| 17 | 29.174 | 64 | 50 | 56.0 | 24 | 269 | ..... |
| 18 | 29.213 | 66 | 50 | 55.9 | 12 | 155 | ..... |
| 19 | 29.156 | 71 | 50 | 61.3 | 12 | 150 | ..... |
| 20 | 28.971 | 68 | 58 | 58.6 | 8 | 102 | 0.66 |
| 21 | 28.876 | 58 | 49 | 52.0 | 28 | 256 | ..... |
| 22 | 29.028 | 66 | 46 | 58.0 | 10 | 144 | ..... |
| 23 | 28.837 | 66 | 58 | 59.3 | 24 | 164 | 0.05 |
| 24 | 28.644 | 60 | 51 | 55.5 | 20 | 213 | 0.16 |
| 25 | 29.033 | 60 | 45 | 49.2 | 32 | 355 | 0.05 |
| 26 | 28.978 | 61 | 40 | 51.9 | 24 | 265 | ..... |
| 27 | 28.966 | 61 | 49 | 52.3 | 24 | 332 | ..... |
| 28 | 29.109 | 49 | 42 | 43.0 | 24 | 335 | ..... |
| 29 | 28.994 | 52 | 40 | 46.5 | 12 | 141 | ..... |
| 30 | 28.977 | 55 | 30 | 45.0 | 18 | 166 | ..... |
| Means. | 29.058 | 65.8 | 49.0 | 56.6 | Sums | 6,443 | 2.39 |

Highest barometer, 29.455 in.; lowest, 28.603 in. Highest temperature, 79°; lowest, 38°. Maximum velocity of wind, 36 miles. Prevailing winds, S., N., S. E., S. W. No. of cloudy days, 11; No. of fair days, 8; No. of clear days, 11. Range of thermometer, 41°; Range of barometer, 0.852 inches.

Memoranda: No. of times blew from the N., 19; N. E., 7; E., 6; S. E., 11; S., 21; S. W., 10; W., 7; N. W., 9. (Three observations daily.)

METEOROLOGICAL RECORD FOR THE MONTH OF OCTOBER, 1888.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches | ° | ° | ° | Miles | | Inch's |
| 1 | 28.851 | 53 | 34 | 44.7 | 12 | 134 | 0.10 |
| 2 | 28.839 | 57 | 49 | 61.7 | 15 | 155 | ..... |
| 3 | 29.246 | 49 | 37 | 41.7 | 16 | 254 | ..... |
| 4 | 29.260 | 49 | 35 | 44.2 | 16 | 143 | ..... |
| 5 | 29.030 | 52 | 46 | 49.3 | 20 | 264 | 0.13 |
| 6 | 29.184 | 53 | 48 | 51.0 | 20 | 182 | ..... |
| 7 | 29.152 | 64 | 47 | 56.0 | 16 | 176 | 0.10 |
| 8 | 28.791 | 79 | 54 | 58.6 | 32 | 455 | ..... |
| 9 | 28.873 | 71 | 57 | 61.0 | 48 | 475 | 0.27 |
| 10 | 29.121 | 61 | 52 | 54.2 | 14 | 114 | 0.61 |
| 11 | 29.088 | 60 | 47 | 54.0 | 12 | 116 | ..... |
| 12 | 29.078 | 55 | 43 | 44.6 | 18 | 187 | 0.12 |
| 13 | 29.063 | 46 | 34 | 37.0 | 28 | 438 | 1.41 |
| 14 | 29.329 | 45 | 34 | 43.0 | 30 | 383 | ..... |
| 15 | 29.551 | 50 | 34 | 41.0 | 16 | 163 | ..... |
| 16 | 29.498 | 51 | 32 | 41.0 | 22 | 185 | ..... |
| 17 | 29.088 | 56 | 39 | 51.7 | 28 | 378 | ..... |
| 18 | 28.822 | 62 | 53 | 57.8 | 40 | 512 | 0.78 |
| 19 | 29.150 | 57 | 44 | 47.0 | 24 | 248 | ..... |
| 20 | 29.479 | 44 | 28 | 33.6 | 26 | 411 | ..... |
| 21 | 29.328 | 38 | 33 | 35.3 | 18 | 217 | ..... |
| 22 | 29.295 | 42 | 34 | 35.9 | 18 | 179 | ..... |
| 23 | 29.350 | 46 | 37 | 39.8 | 16 | 163 | ..... |
| 24 | 29.227 | 40 | 35 | 38.9 | 26 | 356 | ..... |
| 25 | 29.037 | 43 | 35 | 39.8 | 28 | 489 | 0.10 |
| 26 | 29.031 | 48 | 36 | 42.6 | 28 | 209 | ..... |
| 27 | 28.880 | 47 | 41 | 44.0 | 20 | 232 | ..... |
| 28 | 28.634 | 51 | 44 | 48.6 | 20 | 280 | 0.10 |
| 29 | 28.478 | 50 | 44 | 46.5 | 14 | 155 | 0.06 |
| 30 | 28.789 | 51 | 39 | 44.4 | 45 | 357 | ..... |
| 31 | 29.060 | 45 | 33 | 36.9 | 36 | 426 | ..... |
| Means. | 29.081 | 52.1 | 40.6 | 46.3 | Sums | 8,372 | 3.79 |

Highest barometer, 29.557 in.; lowest, 28.448 in. Highest temperature, 79°; lowest, 28°. Maximum velocity of wind, 48 miles; Prevailing winds, S. E., N., N. W. No. of cloudy days, 20; No. of fair days, 5; No. of clear days, 6. Range of thermometer, 51°; range of barometer, 1.109 in.

Memoranda: No. times wind blew from N., 15; E., 6; S., 12; W., 8; N. E., 11; S. E., 20; S. W., 7; N. W., 14. (Three observations daily.)

METEOROLOGICAL RECORD FOR THE MONTH OF NOVEMBER, 1883.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind. | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ° | ° | Miles. | | Inch's |
| 1 | 29.253 | 41 | 29 | 33.8 | 32 | 406 | ..... |
| 2 | 29.134 | 48 | 26 | 39.9 | 24 | 212 | ..... |
| 3 | 28.924 | 55 | 41 | 46.0 | 28 | 482 | ..... |
| 4 | 28.934 | 58 | 33 | 48.4 | 20 | 195 | 0.95 |
| 5 | 28.634 | 60 | 48 | 52.0 | 44 | 537 | ..... |
| 6 | 29.126 | 49 | 33 | 36.1 | 26 | 304 | 0.32 |
| 7 | 28.891 | 44 | 31 | 39.3 | 34 | 277 | 0.05 |
| 8 | 28.734 | 55 | 33 | 45.4 | 28 | 158 | ..... |
| 9 | 28.773 | 49 | 41 | 44.2 | 18 | 208 | 0.40 |
| 10 | 28.903 | 49 | 36 | 39.4 | 16 | 173 | ..... |
| 11 | 29.035 | 46 | 22 | 29.5 | 48 | 430 | ..... |
| 12 | 29.285 | 31 | 17 | 26.2 | 48 | 522 | ..... |
| 13 | 28.832 | 41 | 21 | 28.1 | 40 | 521 | ..... |
| 14 | 29.091 | 21 | 8 | 16.5 | 36 | 479 | ..... |
| 15 | 29.321 | 24 | 6 | 9.1 | 32 | 511 | ..... |
| 16 | 29.288 | 25 | 2 | 19.3 | 38 | 408 | ..... |
| 17 | 28.999 | 44 | 22 | 33.0 | 34 | 559 | ..... |
| 18 | 28.959 | 48 | 25 | 36.4 | 24 | 240 | ..... |
| 19 | 28.904 | 51 | 34 | 43.2 | 26 | 356 | ..... |
| 20 | 28.650 | 54 | 39 | 47.3 | 24 | 389 | 0.15 |
| 21 | 28.734 | 47 | 31 | 31.5 | 24 | 252 | 0.30 |
| 22 | 28.957 | 32 | 27 | 30.0 | 24 | 188 | ..... |
| 23 | 28.897 | 40 | 30 | 36.8 | 22 | 214 | ..... |
| 24 | 29.150 | 43 | 34 | 36.7 | 16 | 181 | ..... |
| 25 | 28.656 | 57 | 34 | 51.1 | 32 | 389 | 0.09 |
| 26 | 29.115 | 58 | 15 | 18.6 | 60 | 613 | ..... |
| 27 | 29.213 | 36 | 13 | 29.0 | 46 | 408 | ..... |
| 28 | 29.500 | 34 | 24 | 25.7 | 38 | 416 | ..... |
| 29 | 28.973 | 36 | 22 | 32.7 | 20 | 240 | ..... |
| 30 | 28.991 | 34 | 27 | 31.2 | 26 | 279 | ..... |
| Means. | 28.996 | 42.9 | 27.6 | 34.5 | Sums. | 10,547 | 2.26 |

Highest barometer, 29.537 inches; lowest, 28.410 inches; highest temperature, 60°; lowest, 2°; maximum velocity of wind, 60 miles; prevailing winds, S., N. W., W.; No. of cloudy days, 10; No. of fair days, 5; No. of clear days, 15; range of thermometer, 58°; range of barometer, 1.127 inches.

Memoranda: No. of times wind blew from the N., 3; E., 2; S., 36; W., 9; N. E, 1; S. E., 5; S. W., 11; N. W., 23. (Three observations daily.)

METEOROLOGICAL RECORD FOR THE MONTH OF DECEMBER, 1883.

| Day. | Mean daily barometer. | Maximum thermometer. | Minimum thermometer. | Mean daily temperature. | Maximum velocity of wind. | Wind, number of miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| | Inches. | ° | ° | ° | Miles. | | Inch's |
| 1 | 28.801 | 49 | 32 | 37.1 | 26 | 327 | ..... |
| 2 | 29.212 | 35 | 17 | 26.8 | 36 | 420 | ..... |
| 3 | 29.022 | 36 | 16 | 26.5 | 28 | 295 | ..... |
| 4 | 28.893 | 42 | 29 | 35.8 | 24 | 271 | ..... |
| 5 | 29.143 | 43 | 31 | 35.1 | 11 | 122 | ..... |
| 6 | 28.828 | 51 | 32 | 43.7 | 18 | 241 | 0.30 |
| 7 | 28.808 | 51 | 28 | 36.0 | 30 | 498 | ..... |
| 8 | 29.156 | 36 | 24 | 26.0 | 22 | 347 | ..... |
| 9 | 29.131 | 42 | 25 | 36.2 | 16 | 156 | ..... |
| 10 | 29.309 | 38 | 29 | 33.2 | 28 | 351 | ..... |
| 11 | 29.121 | 44 | 29 | 38.9 | 29 | 280 | ..... |
| 12 | 29.046 | 45 | 28 | 37.8 | 28 | 240 | ..... |
| 13 | 28.733 | 44 | 36 | 38.5 | 30 | 215 | ..... |
| 14 | 29.159 | 37 | 12 | 16.5 | 32 | 448 | ..... |
| 15 | 29.100 | 15 | 9 | 12.6 | 22 | 274 | —* |
| 16 | 28.896 | 18 | 5 | 19.5 | 24 | 266 | 0.11 |
| 17 | 28.536 | 14 | — 3 | 8.9 | 24 | 281 | 0.35 |
| 18 | 29.082 | 17 | — 5 | 0.7 | 22 | 336 | ..... |
| 19 | 29.345 | 0 | —11 | — 3.4 | 10 | 128 | ..... |
| 20 | 29.258 | 14 | — 4 | 4.1 | 15 | — | 0.07 |
| 21 | 29.228 | 17 | 0 | 8.5 | 18 | 197 | —* |
| 22 | 29.218 | 9 | 1 | 6.6 | 22 | 275 | 0.07 |
| 23 | 28.748 | 24 | 8 | 22.1 | 28 | 380 | 0.52 |
| 24 | 28.848 | 25 | 11 | 20.0 | 15 | 190 | ..... |
| 25 | 28.728 | 27 | 12 | 22.3 | 16 | 195 | ..... |
| 26 | 28.617 | 34 | 17 | 24.1 | 40 | 457 | 0.48 |
| 27 | 29.047 | 17 | 1 | 3.8 | 40 | 518 | ..... |
| 28 | 28.985 | 22 | — 2 | 13.9 | 28 | 189 | ..... |
| 29 | 28.871 | 24 | 6 | 19.4 | 13 | 132 | ..... |
| 30 | 29.035 | 25 | 22 | 23.9 | 28 | 403 | 0.05 |
| 31 | 29.288 | 25 | 16 | 21.1 | 16 | 300 | ..... |
| Means. | 29.025 | 29.6 | 14.6 | 22.33 | Sums. | 8934 | 1.95 |

Highest barometer, 29.454 in.; lowest, 28.398 in.; highest temperature, 51°; lowest, —11°; maximum velocity of wind, 40 miles; prevailing winds, N., W., S., N. W.; No. of cloudy days, 10; No. of fair days, 10; No. of clear days, 11; range of thermometer, 62°; range of barometer, 1.056 in.

Memoranda. No. times the wind blew from the N., 14; N. E., 6; E., 1; S. E., 6; S., 23; S. W., 10; W., 8; N. W., 24. (Three observations daily.)

* Precipitation too small to be measured.

METEOROLOGICAL SUMMARY FOR THE YEAR 1883.

| Month. | Mean monthly barometer. | Mean maximum thermometer. | Mean minimum thermometer. | Mean monthly temperature. | Maximum velocity of wind. | Wind, number miles traveled. | Rainfall. |
|---|---|---|---|---|---|---|---|
| 1883. | Inches. | ° | ° | | Miles. | | Inch's |
| January.... | 29.043 | 18.3 | —4.6 | 8.5 | 25 | 6,666 | 1.01 |
| February... | 29.169 | 25.6 | 7.8 | 17.0 | 28 | 6,112 | 1.64 |
| March..... | 28.995 | 36.7 | 19.6 | 27.1 | 32 | 7,606 | 0.32 |
| April..... | *—— | ..... | ..... | ..... | ..... | ..... | ..... |
| May..... | 28.883 | 63 5 | 43.7 | 51.5 | ..... | ..... | 6.98 |
| June..... | 28.872 | 74.5 | 55.9 | 65.2 | ..... | ..... | 7.57 |
| July..... | 29.928 | 79.1 | 60.8 | 70.2 | ..... | ..... | 8.89 |
| August..... | 29.027 | 78.3 | 59.2 | 66.1 | 36 | 5,458 | 2.74 |
| September . | 29.058 | 65.8 | 49.0 | 56.6 | 36 | 6,443 | 2.39 |
| October.. .. | 29.081 | 52.1 | 40.6 | 46.3 | 48 | 8,372 | 3.79 |
| November.. | 28.996 | 42.9 | 27.6 | 34.5 | 60 | 10,547 | 2.26 |
| December .. | 29.009 | 29.6 | 14.6 | 22.3 | 40 | 8,934 | 1.95 |
| Means..... | †29.006 | ‡51.5° | ‡34.1° | †42.3° | Sums. | **60,138 | †39·54 |

Highest barometer,† 29.608 in.; lowest,† 28.332 in.; highest temperature,† 89°; lowest, †—23°; maximum velocity of wind, 60 miles; prevailing winds, N. W., W., S. W., S.; No. of cloudy days,† 108; No. of fair days,† 121; No. of clear days,† 99; range of thermometer,† 112°; range of barometer,† 1.276 in.

Memoranda: No. times† wind blew from the N., 127; E., 46; S., 173; W., 126; N. E., 77; S. E., 95; S. W., 150; N. W., 187. (Three observations daily.)

NOTE — Observations for January, February and March were taken at the U. S. Signal Station, Madison. Observations for April were not taken. Observations from May 1st to May 5th, and From May 11th to July 30th were taken at the North Dormitory, University. Observations from August 2d throughout the remainder of the year were taken at Washburn Observatory.

** For 233 days.
† For 328 days,
‡ For 321 days.
* No observations were taken during April.

# XVIII. METEOROLOGICAL OBSERVATIONS AT MADISON DURING THE YEARS 1853–1883.

In Vol. I. of the *Publications of the Washburn Observatory*, tables of meteorological observations from 1872-1881, were given which were furnished by the U. S. Signal observer at Madison. The Washburn Observatory has since come into possession of most of the original records of observation and I have thought it proper to give summaries of all the observations which have been made in Madison, and especially at the University. In cases of discrepancy between Vol. I and the present volume, the latter is to be preferred.

The compilation has been done by Mr. G. W. BROWN, Meteorological Observer.

The detailed tables are not given here, as I have furnished them for printing in the First Annual Report of the Agricultural Experiment Station of the University.

All the observations have been made thrice daily, at 7 A. M., 2 P. M. and 9 P. M.

From 1853 January, to 1864 June, the data are taken from the manuscript records, (re-reduced in some cases) supplemented by the numbers given in the *Results of Meteorological Observations made under the U. S. Patent Office and Smithsonian Institution from* 1854 *to* 1859 *inclusive*, (Vol. I): from 1869 January, to 1878 October, the data are from the *ms.* records, supplemented by the (printed) annual reports of Prof. W. W. DANIELLS to the Regents of the University; from 1878 October, to 1883 April, from the *ms.* records of the U. S. Signal Station at Madison; from 1883 April, to 1884, January, from the *ms.* records of observations at the Washburn Observatory.

### OBSERVERS AND PLACES OF OBSERVATION.

From 1853 January to 1855 June, the observations were made by Prof. J. H. CARPENTER, at the North Dormitory, University. From 1854 June to 1856 January, they were made by Prof. J. W. STERLING, at the North Dormitory. From 1856 March to 1857 January, the observations were made by Dr. A. SCHUE at (his office on Main street city of Madison?). From 1857 January to 1864 May, they were made by Prof. J. W. STERLING at the North Dormitory and at the Main Building of the University. From 1869 January to 1878 October, they were made by Prof. W. W. DANIELLS, at the latter place. From 1878 October to 1883 April, they were made by Sergeants F. M. M. BEALL and C. A. SHAW, at the U. S. Signal Station, Brown's block, in the city of Madison. From 1883 May to 1883 August, they were made by Mr. J. C. OFFICER, at the North Dormitory. From 1883 August to 1883 December 31, they were made by Mr. JOHN TATLOCK and Mr. G. W. BROWN at the Washburn Observatory.

### NOTES ON THE OBSERVATIONS.

Beside the special remarks with the tables, the following general facts should be noted: In all cases where the observations were made for a portion of a month only, the rainfall, the number of days on which snow or rain fell, and the movement of the wind have been omitted from the monthly means and sums. Up to October 1879, the maximum and minimum temperature given, were simply the highest and lowest readings of the thermometer at the regular hours of observation, viz: 7 A. M., 2 P. M. and 9 P. M. After that date they are read from self-recording instruments. Up to October 1876, the maximum velocity of the wind is simply the greatest velocity recorded (estimated) at these three hours. The maximum velocity during May, June, July, 1883, is the greatest velocity recorded by the anemometer, at the hours 7, 2, 9. During the rest of the series, it is the highest velocity of the twenty-four hours, from 2 P. M. to 2 P. M., as read from the anemometer sheets.

## SUMMARY OF METEOROLOGICAL OBSERVATIONS FROM 1869 TO 1883, BY YEARS.

N. B.— See remarks at end of the table.

| Year. | Mean yearly barometer. (Inches.) | Mean yearly temperature. | Highest temperature of the year. | Lowest temperature of the year. | Range of temperature for the year. | Rain, or melted snow. (Inches.) | Mean relative humidity. Per cent. | No. days on which rain or snow fell | Prevailing wind. | Maximum velocity of wind. (Miles per hour.) | Yearly movement of wind. (Miles.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1869 | 28.966 | 42.9 | 89 | —11 | 100 | 43.27 | 79.2 | 103 | N. W. | 45 | ..... |
| 1870 | 28.920 | 47.2 | 98 | —13 | 111 | 27.83 | 69.5 | 93 | N. W. | 35 | ..... |
| 1871 | 28.903 | 46.1 | 91 | —15 | 106 | 29.51 | 70.7 | 103 | W. | 35 | ..... |
| 1872 | 28.897 | 44 4 | 92 | —28 | 120 | 22.44 | 73.9 | 87 | S.W. / N. W. | 35 | ..... |
| 1873 | 28.893 | 43.8 | 91 | —21 | 112 | 26.49 | 76.5 | 80 | N. W. / S. W. | 35 | |
| 1874 | 28.950 | 45.5 | 96 | —15 | 111 | 29.02 | 74.1 | 85 | S. W. | 35 | ..... ... |
| 1875 | 28.917 | 42.4 | 86 | —25 | 111 | 22.59 | 74.2 | 100 | W. / S. W. | 25 | ..... .... |
| 1876 | 28.921 | 46.1 | 90 | —22 | 112 | 36.04 | 78.3 | 93 | N. W. / S. W. | 35 | ..... |
| 1877 | 28.887 | 47.7 | 88 | —16 | 104 | 27.67 | 77.3 | 84 | S. W. | 25 | ..... ..... |
| 1878 | 28.721 | 49.7 | 92 | — 9 | 101 | 39.54 | 71.7 | 104 | N. W. | 50 | [23132] |
| 1879 | 28.993 | 47.9 | 91 | —22 | 113 | 35.10 | 68.7 | 106 | S. | 48 | 87425 |
| 1880 | 28.989 | 48.1 | 93 | —21 | 114 | 46.72 | 70.0 | 138 | S. / W. | 50 | 90855 |
| 1881 | 29.001 | 46.9 | 95 | —20 | 115 | 52.92 | 72.4 | 158 | N. W. / S. | 45 | 84342 |
| 1882 | 29.005 | 47.1 | 87 | —13 | 100 | 42.89 | 75.3 | 160 | N. W. / W. | 48 | 85448 |
| 1883 | 29.006 | 42.3 | 89 | —23 | 112 | 39.54 | 77.9 | 121 | N. W. / S. | 60 | [60138] |
| Means. | 28.931 | 45.9 | 91.0 | —19.8 | 110.8 | 34.77 | 74.0 | 106 | N. W. / S. W. | 50.2 | 87018 |

Remarks.— For 1878, the maximum velocity of the wind and the No. of miles traveled were observed for October, November, December, only.

For 1883, the same data are for 233 days only; the maximum and minimum Thermometer and Range of Temperature for 323 days. The other data for 328 days.

The mean Barometer, temperature, rainfall, humidity, No. of days on which snow or rain fell, are given from all the data 1869–1883. The *mean* highest and lowest temperature, the range, and the maximum velocity and number of miles traveled by the wind, relate only to the years 1879–1883.

## SUMMARY OF METEOROLOGICAL OBSERVATIONS FROM 1853 TO 1883, BY MONTHS.

| MONTH. | Mean monthly Barometer (inches). 1853-1883. | Mean monthly temperature. 1853-1883. | Mean maximum temperature. 1879-1883. | Mean minimum temperature. 1879-1883. | Mean monthly range of temperature. 1879-1883. | Mean monthly fall of rain or melted snow (inches). 1853-1883. | Mean relative humidity (per cent). 1855-1883. | Mean number of days on which rain or snow fell. 1853-1883. | Mean direction of wind. 1858-1883. | Mean maximum velocity of wind (miles per hour). 1879-1883. | Mean monthly movement of the wind (miles.) 1879-1883. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 28.994 | 18.4 | 44.5 | —13.4 | 57.9 | 1.60 | 81.6 | 8.5 | S. W. | 32.0 | 7323 |
| February | 28.979 | 22.1 | 51.6 | — 5.8 | 57.4 | 1.65 | 80.7 | 7.0 | N. W. | 32.6 | 7706 |
| March | 28.901 | 31.0 | 57.8 | 5.2 | 52.6 | 2.04 | 72.0 | 7.8 | N. W. | 37.2 | 8834 |
| April | 28.883 | 44.5 | 77.7 | 17.0 | 60.7 | 2.27 | 66.2 | 8.4 | S. W. S. | 40.2 | 8053 |
| May | 28 916 | 58.0 | 83.2 | 35.0 | 47.2 | 3.74 | 64.1 | 9.8 | S. N. E. | 33.0 | 7230 |
| June | 28.899 | 67.2 | 87.2 | 46.0 | 41.2 | 4.72 | 69.7 | 10.0 | S. W. | 39.0 | 6186 |
| July | 28.960 | 72.6 | 90.4 | 53.2 | 37.2 | 4.18 | 68.3 | 8.0 | S. W. | 27.7 | 5499 |
| August | 28.959 | 70.0 | 90.0 | 50.0 | 40.0 | 3.17 | 69.2 | 8.0 | S. N. W. | 34.6 | 5641 |
| September | 28.977 | 61.2 | 83.8 | 40.8 | 43.0 | 3.35 | 69.9 | 8.1 | S. | 32.8 | 6408 |
| October | 28.973 | 48.5 | 77.9 | 27.7 | 50.2 | 3.03 | 71.2 | 8.3 | S. | 38.0 | 7708 |
| November | 28.954 | 33.7 | 61.7 | 8.8 | 52.9 | 2.13 | 77.2 | 8.2 | N. W. | 35.7 | 8312 |
| December | 28.992 | 22.6 | 46.0 | — 9.8 | 55.8 | 1.55 | 80.7 | 9.0 | N. W. | 34.8 | 7880 |
| Means. | 28.949 | 45.8 | ..... | ..... | 48.0 | 2.78 | 72.6 | 8.4 | ..... | 34.8 | 7237 |
| Sums. | ..... | ..... | ..... | ..... | ..... | 33.41 | ..... | 101.1 | ..... | ..... | 86836 |

## TIMES OF SUNRISE AND SUNSET AT MADISON FOR EVERY TENTH DAY OF THE YEAR.

NOTE — The times are given in the local time of the 90th meridian from Greenwich. (Central times.)

| Day of the year. | Time of sunrise. | Time of sunset. | Day of the year. | Time of sunrise | Time of sunset. |
|---|---|---|---|---|---|
| | h. m. | h. m. | | h. m. | h. m. |
| January 1 | 7 30 | 4 34 | July 1 | 4 21 | 7 41 |
| 11 | 7 28 | 4 45 | 11 | 4 28 | 7 38 |
| 21 | 7 23 | 4 56 | 21 | 4 37 | 7 31 |
| February 1 | 7 13 | 5 10 | August 1 | 4 48 | 7 20 |
| 11 | 7 1 | 5 25 | 11 | 4 58 | 7 7 |
| 21 | 6 48 | 5 37 | 21 | 5 10 | 6 52 |
| March 1 | 6 35 | 5 48 | September 1 | 5 22 | 6 34 |
| 11 | 6 16 | 6 0 | 11 | 5 33 | 6 16 |
| 21 | 5 58 | 6 12 | 21 | 5 43 | 5 58 |
| April 1 | 5 41 | 6 24 | October 1 | 5 56 | 5 40 |
| 11 | 5 23 | 6 35 | 11 | 6 7 | 5 23 |
| 21 | 5 8 | 6 48 | 21 | 6 20 | 5 6 |
| May 1 | 4 52 | 6 59 | November 1 | 6 33 | 4 51 |
| 11 | 4 39 | 7 10 | 11 | 6 46 | 4 38 |
| 21 | 4 28 | 7 20 | 21 | 6 58 | 4 30 |
| June 1 | 4 20 | 7 30 | December 1 | 7 10 | 4 25 |
| 11 | 4 17 | 7 36 | 11 | 7 20 | 4 24 |
| 21 | 4 17 | 7 41 | 21 | 7 28 | 4 27 |

## XIX. LIST OF THIRTY-EIGHT AURORAS SEEN AT THE WASHBURN OBSERVATORY, 1881–2–3.

NOTE: The times are Chicago mean times until November 23, 1883, and after that date they are $2^m\ 22^s$ slow of Madison mean time. Those marked with a star are not in the list of Auroras observed at Sauk City.

No. 1. 1881. Dec. 10.* Through a break in the clouds an aurora was seen about $9^h$ for $10^m$. It was 15° high and looked rosy. All cloudy after $9^h\ 30^m$.

2. 1881. Dec. 23. Low auroral arch first seen $6^h\ 30^m$; $10^h\ 35^m$ much fainter. Still a faint arch $12^h\ 30^m$.

3. 1882. Jan. 11. Low auroral arch first seen $8^h\ 27^m$.

4. 1882. Jan. 19. Low auroral arch first seen $6^h\ 30^m$; Double arch about $9^h\ 6^m$. Aurora still present about $12^h$.

5. 1882. Jan. 27.* Aurora first seen $6^h\ 32^m$. End $9^h\ 50^m$. Not very bright.

6. Jan. 31.* Dense clouds. At $6^h\ 5^m$ a large rosy patch of Aurora (?) was seen in the N. E. at an altitude of about 10°. At $6^h\ 6^m$ the clouds had covered it. [It is quite possible that this was due to fires of brushwood, as I have seen such cases.]

7. Feb. 5. Auroral arch 10°–12° high. First seen 6 $45^m$. Disappeared at $7^h\ 45^m$.

8. Feb. 9. Aurora with streamers. First seen $10^h\ 3^m$.

No. 9. April 16. At $9^h\ 24^m$ a fine auroral arch first seen. All white and a simple arch. This continued moving upward, and at $9^h\ 36^m$ included *Polaris*. Between $10^h$ and $11^h$ it formed a splendid corona with rays to all parts of the horizon. At $11^h\ 24^m$ it was the brightest and most magnificent display I have ever seen. There was rather less rosy color in it than in displays of the kind which I remember. The telegraph wires between Chicago and New York could not be worked. Between Chicago and St. Paul a few messages were sent by the atmospheric electricity alone.

See *Nature*, May 18, 1882, for an account of the magnetic disturbances. Also — Note on the aurora of April 16–17, by Professor H. C. LEWIS, Trans. Amer. Phil. Soc., April 21, 1882.

10. April 20. $8^h\ 20^m$ auroral arch, altitude of 14°, $10^h\ 0^m$ 3 streamers upwards; $10^h\ 5^m$ almost vanished: $10^h\ 50^m$ arch as at $8^h\ 20^m$; $11^h\ 10^m$, 5 bright streamers.

11. May 14.* Faint aurora seen at $12^h\ 30^m$ low down.

12. June 12.* Auroral arch; first seen $11^h\ 14^m$.

13. June 14.* Bright Aurora, first seen behind clouds $11^h$.

14. June 15.* Auroral arch; dark segment, streamers; first seen $11^h\ 30^m$.

15. July 16.* Aurora. First seen $9^h\ 50^m$. Streamers $10^h\ 0^m$. Simple arch $10^h\ 15^m$, low arch spreading, both east and west, $11^h\ 20^m$.

16. Aug. 9.* $10^h$, no aurora; $11^h\ 35^m$ low arch; $12^h$ arch was brighter and higher.

17. Aug. 16.* Faint aurora $10^h\ 0^m$, brighter at $11^h\ 30^m$, gone at $12^h$.

18. Aug. 21.* Bright aurora, $10^h\ 45^m$. Streamers and some rosy color, $11^h$—$11^h\ 30^m$.

19. Sept. 3. Bright aurora with streamers about $9^h$.

No. 20. Sept. 11.* Bright aurora first seen $9^h$ $0^m$. Sky clouded later.

21. Oct. 16. Auroral arch first seen $7^h$ $40^m$. Still visible $11^h$ $40^m$.

22. Oct. 30. $6^h$ $30^m$.* Large aurora seen through heavy clouds. Raining.

23. Nov. 13. Bright aurora.

24. 1882. Dec. 15. Aurora $11^h$ $0^m$ to $12^h$ $30^m$.

25. 1883. Feb. 4.* Aurora behind clouds, pretty bright $12^h$ $30^m$.

26. July 29. Bright auroral arch and streamers 50° high, far in the west and east also, $10^h$.

27. July 30. Low auroral arch — no streamers between $9^h$ and $10^h$.

28. July 31. Low arch; streamers at $9^h$; low arch at $12^h$.

29. Aug. 2.* $11^h$ $15^m$. Noticed streamers *like* Aurora in the W. They radiated from a point N. 30° W. with dark spaces between and covered much of the sky, extending even to the east point opposite. The northern sky had no arch, but was covered with streamers very narrow and close together. The appearance was suspiciously similar in form to stratus clouds; but it looked like Aurora. $11^h$ $40^m$ same; $13^h$ sky overcast.

30. Aug. 5.* Low arch, first seen $11^h$ $40^m$.

31. Aug. 7. Arch 10° high $9^h$ $0^m$; dark segment. $11^h$ gone. Hazy sky.

32. Sept. 4. $9^h$ small but well defined arch. No dark segment. Still there $11^h$.

33. Sept. 5.* Faint auroral light in N. horizon. $10^h$ $20^m$. Well defined arch. Dark segment. $12^h$ $15^m$. Brighter.

34. Sept. 16. Brilliant aurora. First seen $7^h$ $17^m$. Streamers up to 45° altitude. Undulatory motion east and west. At $9^h$ $15^m$ it had disappeared except a faint light on horizon.

No. 35. Sept. 25. $9^h\ 40^m$. Bright well defined arch. Dark segment. $12^h\ 15^m$ same.

36. Nov. 1. $7^h\ 30^m$. Brilliant arch in North Horizon. Dark segment. $12^h$ same.

37. Nov. 2. $7^h$. Light in north; but could not distinguish its shape on account of clouds.

38. Dec. 1. $8^h\ 45^m$. Low arch. Dark segment.

## XX. LIST OF 608 AURORAS OBSERVED AT SAUK CITY, WISCONSIN, FROM 1859 TO 1884, BY F. G. T. LUEDERS.

"At the request of the Director of the Washburn Observatory, I have extracted from my journal of observations of the Aurora Borealis, which extends from July 1859, to the present time, a series of notes for publication. The observations were made at Sauk City, which is in latitude 43° 15′, and longitude 12° 40′ W. of Washington. In general, the observations were closed at 10 or 11 p. m., but in a great many cases they have been prolonged throughout the night.

The terms "dim," "faint" denote a low intensity in the luminous source, while "high streamers," etc., shows that the Aurora was brilliant. "Low" indicates that the nebulous segment or the luminous arch was only a few degrees above the horizon, while "extensive" is applied to those cases where the arches rose to the height of 20° or more. The frequent occurrence of Polar Lights and Heat Lightning (*Wetterleuchten*) together, has attracted my attention, and I have noted such cases. In the following list I have also included sixty-two luminous appearances which have presented themselves in or near the direction of the magnetic meridian, which could not be certainly identified as Auroras, on account of clouds, etc. These have received no numbers in the list, and in the column of remarks are denoted by A."

F. G. T. LUEDERS.

SAUK CITY, WISCONSIN.
1884, March.

## LIST OF AURORAS 1859—1884.

| No. | Year—Month. | Day. | Remarks. |
|---|---|---|---|
| | 1859 | | |
| 1 | July | 10 | Average brilliancy. |
| 2 | July | 11 | Average brilliancy. |
| 3 | July | 18 | Beams shooting up beyond Polaris. *Heat-lightning.* |
| 4 | August | 28 | Began 1$^h$ after sunset, and soon after spread over the whole northern and a part of the southern sky. High streamers. |
| 5 | September | 3 | Average brilliancy. |
| 6 | September | 4 | Average brilliancy. |
| 7 | September | 13 | Average brilliancy. |
| 8 | September | 16 | Average brilliancy. |
| 9 | September | 24 | Average brilliancy. |
| 10 | September | 27 | Average brilliancy. |
| 11 | October | 18 | After 12$^h$ medium streamers. |
| 12 | October | 20 | Rather faint. |
| 13 | October | 23 | Rather faint. |
| 14 | November | 13 | Average brilliancy. |
| 15 | December | 14 | Began 7$^h$; at 9$^h$ only a trace left. |
| | 1860. | | |
| 16 | January | 1 | Average brilliancy. |
| 17 | January | 11 | Average brilliancy. |
| 18 | January | 20 | Low and faint. |
| 19 | February | 18 | Began 9$^h$. No marked features for 2 hours. |
| 20 | March | 13 | Nothing peculiar in appearance. |
| 21 | March | 23 | A thick, dark greyish haze covers a part of the southern sky and also a part of the northern, down to 3° from the horizon. This haze is in constant motion. When separated into clouds, beams of light are plainly seen. |
| 22 | March | 26 | Greatly extended but faint. |
| .... | March | 28 | A. |
| 23 | March | 29 | Average brilliancy. |
| 24 | April | 12 | Average brilliancy. |
| 25 | April | 13 | Average brilliancy. High wind. |
| 26 | April | 14 | Average brilliancy. |
| 27 | May | 6 | Average brilliancy. |
| 28 | May | 10 | High streamers. |
| 29 | May | 12 | Average brilliancy. |
| 30 | May | 14 | Low; but streamers. |
| .... | May | 17 | A. |
| 31 | May | 18 | Vivid; streamers. |
| 32 | July | 4 | Began 8$^h$ 15$^m$. Thunder storm in the north. Aurora very extensive. Streamers pass through the zenith. At 11$^h$ faint. |
| 33 | July | 18 | Very active streamers; heat-lightning in the south. |

LIST OF AURORAS, 1859–1884.

| No. | Year — Month. | Day. | Remarks. |
|---|---|---|---|
| 34 | July | 19 | Moderate streamers; heat-lightning in the south. |
| 35 | August | 7 | Dim; not much extended. |
| 36 | August | 8 | Luminous arches moving up and down, emitting beams at intervals. |
| 37 | August | 9 | Average brilliancy. Thunder storm in the north. |
| 38 | August | 10 | Of great extent, but faint. |
| 39 | August | 12 | Vivid beams extending to zenith. |
| 40 | August | 13 | Dim and low. |
| .... | August | 14 | A. |
| 41 | August | 16 | Low. |
| 42 | August | 18 | Moderate. Heat-lightning S. E. |
| 43 | August | 21 | Moderate. |
| 44 | August | 23 | Aurora in the zenith. |
| .... | August | 24 | A. |
| 45 | August | 25 | Dim. |
| 46 | August | 26 | Extended but faint. |
| 47 | August | 27 | Aurora in the zenith. |
| 48 | August | 28 | Low. |
| 49 | August | 29 | Low. |
| 50 | August | 30 | Average brilliancy. |
| 51 | September | 1 | Average brilliancy. |
| 52 | September | 5 | Average brilliancy. |
| 53 | September | 6 | Average brilliancy. |
| 54 | September | 7 | Extended, but faint. Thunderstorm, gale and heavy rain, interrupting the observation. |
| 55 | September | 9 | Average brilliancy. |
| 56 | September | 10 | Aurora in the zenith. |
| 57 | September | 11 | Faint. |
| 58 | September | 12 | Average brilliancy. |
| 59 | September | 16 | Average brilliancy. |
| 60 | September | 17 | Aurora in the zenith. |
| 61 | September | 19 | Aurora in the zenith. |
| 63 | September | 20 | Low, but streamers. |
| 63 | September | 21 | Low. |
| 64 | September | 24 | Low. |
| 65 | September | 25 | Low. From August 7 to September 25 there was almost a continuous aurora. |
| 66 | October | 7 | Aurora in the zenith. |
| 67 | October | 8 | High; streamers. |
| 68 | October | 10 | Aurora in the zenith. |
| 69 | October | 16 | Extended, but faint. |
| 70 | December | 13 | Low and faint. |
| 71 | December | 15 | Average brilliancy. |
| | 1861. | | |
| 72 | January | 31 | Low. |
| 73 | February | 27 | Average brilliancy. |
| 74 | February | 28 | Average brilliancy. |
| 75 | March | 9 | High; streamers. |
| 76 | March | 13 | Low; streamers. |

## LIST OF AURORAS, 1859–1884.

| No. | Year — Month. | Day. | Remarks. |
|---|---|---|---|
| .... | March..... | 30 | A. |
| 77 | April..... | 20 | Vivid; streamers. |
| 78 | May..... | 4 | Low; moderate streameas. |
| .... | June..... | 28 | A. |
| 79 | August..... | 4 | Vivid; streamers. |
| 80 | August..... | 5 | Vivid; streamers. |
| 81 | August..... | 9 | Vivid; str- amers. |
| 82 | August..... | 14 | Very active; moderately high streamers. |
| 83 | August..... | 18 | Moderate; thunderstorm in S. |
| 84 | August..... | 22 | High streamers. |
| .... | August..... | 23 | A. |
| .... | August..... | 27 | A. |
| 85 | August..... | 28 | Aurora in the Zenith. |
| .... | August..... | 30 | A. |
| 86 | September..... | 1 | Average brilliancy. |
| 87 | September..... | 2 | Active; high streamers. |
| 88 | September..... | 3 | High, but faint. |
| 89 | September..... | 5 | Average brilliancy. |
| 90 | September..... | 22 | Average brilliancy. |
| 91 | September. ..... | 27 | Aurora in the zenith; streamers. |
| 92 | September..... | 29 | After $12^h$; streamers. |
| 93 | October..... | 2 | Vivid; streamers. |
| 94 | October..... | 7 | After $12^h$; streamers. |
| 95 | October..... | 11 | Average brilliancy. |
| 96 | December..... | 4 | Active; high streamers. |
| 97 | December..... | 18 | Average b illiancy. |
| 98 | December..... | 20 | Very brilliant, high; streamers. |
| | 1862. | | |
| 99 | January..... | 21 | Average brilliancy. |
| 100 | January..... | 29 | Rather faint. |
| 101 | February..... | 28 | Vivid; high streamers. |
| 102 | March..... | 30 | Average brilliancy. |
| 103 | April..... | 2 | After $12^h$. |
| .... | April..... | 3 | A. |
| 104 | April..... | 13 | Average brilliancy. |
| 105 | April..... | 21 | Average brilliancy. |
| 106 | April..... | 27 | Very brilliant; strong streamers. |
| .... | May..... | 4 | A. |
| 107 | May..... | 13 | Average brilliancy. |
| 108 | May..... | 19 | Rather dim. |
| 109 | June..... | 1 | Extended; but few streamers. |
| 110 | June..... | 12 | High arches; the streamers do not persist long. Thunderstorm in S. W. |
| .... | June..... | 17 | A. |
| .... | June..... | 25 | A. |
| .... | June..... | 26 | A. |
| 111 | June..... | 28 | 9 P. M. A dark grey haze covers the zenith and the upper part of the N. sky. After half an hour the nebulous body moves northwards, forming a segment which touches the horiz n in N. W. and E. N. E. A streaming and whirling commences which lasts for $2^h$ and fades away. |

LIST OF AURORAS, 1859–1884.

| No. | Year — Month. | Day. | Remarks. |
|---|---|---|---|
| 112 | June | 30 | Phenomenon similar to June 28th, but far inferior in intensity. |
| 113 | July | 2 | Strong streamers. |
| 114 | July | 5 | High; streamers. |
| 115 | July | 6 | High; streamers. |
| 116 | July | 7 | High; streamers. |
| 117 | July | 9 | Average brilliancy. |
| 118 | July | 20 | Appeared in E. which is unusual. Heat lightning in N. W. |
| 119 | July | 24 | Low and faint. |
| .... | July | 26 | A. |
| 120 | July | 29 | Not low, but faint. |
| 121 | August | 3 | Moderate streamers. Thunderstorm in N. W. |
| 122 | August | 4 | Same. Thunderstorm in S. W. |
| 123 | August | 8 | Nearly the same, Thunderstorm in S. W. and S. |
| 124 | August | 18 | Average brilliancy. |
| 125 | August | 19 | Extended; isolated beams. |
| 126 | August | 23 | Average brilliancy. |
| 127 | August | 28 | Same; heat lightning in N. W. |
| 128 | August | 31 | High streamers; thunderstorm above the horizon in south. Heat lightning above the horizon in N. E. |
| 129 | September | 1 | High streamers. |
| 130 | September | 3 | Average brilliancy. |
| 131 | September | 25 | Began an hour after sunset and lasted throughout the night till sunrise. |
| 132 | September | 26 | Average brilliancy. |
| 133 | September | 27 | Average brilliancy. |
| 134 | October | 4 | Same. |
| 135 | October | 6 | Same. Thunderstorm in S. |
| 136 | October | 11 | Faint. |
| 137 | October | 21 | Faint; strong gale. |
| 138 | October | 22 | High; streamers. |
| .... | November | 20 | A. |
| 139 | December | 24 | Vivid; streamers. |
| | 1863. | | |
| 140 | January | 8 | Low; streamers. |
| 141 | January | 10 | High; streamers. |
| 142 | January | 24 | Average brilliancy. |
| 143 | February | 22 | Average brilliancy. |
| .... | March | 10 | A. |
| 144 | March | 21 | Average brilliancy. A thunderstorm next morning. |
| 145 | April | 8 | Faint and low. |
| 146 | April | 12 | Average brilliancy. |
| 147 | April | 15 | Same. |
| 148 | April | 17 | Same. |
| 149 | April | 18 | Same. |
| .... | April | 21 | A. |
| .... | May | 21 | A. |

## LIST OF AURORAS, 1859-1884.

| No. | Year—Month. | Day. | Remarks. |
|---|---|---|---|
| 150 | June | 13 | Moderate streamers. |
| 151 | July | 6 | Vivid; high streamers. |
| 152 | July | 23 | Average brilliancy. |
| 153 | July | 26 | Same. |
| 154 | July | 31 | Active streamers. |
| 155 | August | 7 | Began $9^h$ $15^m$ lasted 30 . |
| 156 | August | 14 | Streamers. Heat-lightning in N. E. Thunder storm in S. W. |
| 157 | September | 9 | High: extended; streamers. |
| 158 | September | 13 | 2 A. M. Average brilliancy. |
| 159 | September | 23 | Very extended. The nebulous segment parts into several sub-phenomena; each of which streams towards its own point of convergence. |
| 160 | October | 9 | Rather dim. |
| 161 | October | 10 | Moderate. |
| 162 | October | 12 | Moderate. |
| 163 | October | 14 | Low and faint. |
| .... | October | 20 | A. |
| 164 | November | 2 | Low and faint. |
| 165 | November | 4 | Thunderstorm till 8 P. M. after the clouds disperse, aurora. |
| 166 | November | 8 | Moderate. |
| 167 | December | 1 | Moderate. |
| | 1864. | | |
| 168 | February | 1 | Moderate. |
| 169 | February | 8 | Moderate. |
| 170 | February | 9 | Moderate. |
| 171 | May | 2 | Faint. |
| 172 | August | 24 | Moderate; Heat-lightning S., S. W. |
| 173 | August | 25 | Same: same. |
| .... | August | 30 | A. |
| 174 | September | 20 | Dim. |
| 175 | September | 24 | Low; streamers. |
| 176 | October | 6 | Moderate. |
| 177 | October | 8 | Moderate. |
| 178 | October | 9 | After $12^h$; moderate. |
| 179 | October | 20 | Average brilliancy. |
| 180 | November | 3 | Moderate. |
| 181 | November | 19 | Low and faint. |
| | 1865. | | |
| 182 | January | 17 | Low and faint. |
| .... | January | 18 | A. |
| 183 | January | 29 | Same. |
| 184 | February | 18 | Low and rather dim. |
| 185 | February | 22 | Same. |
| 186 | February | 23 | High streamers. |
| .... | February | 26 | A. |
| 187 | March | 16 | Low and faint. |
| 188 | March | 24 | Same. |

LIST OF AURORAS, 1859–1884.

| No. | Year — Month. | Day. | Remarks. |
|---|---|---|---|
| 189 | April. | 16 | Moderately high. |
| 190 | May | 11 | Very extended; active streamers up to the zenith. |
| 191 | May | 16 | After 12h moderate. |
| 192 | May | 25 | Rather faint. |
| 193 | May | 26 | A few isolated beams. |
| 194 | June | 10 | Vivid; high streamers. |
| 195 | June | 23 | Moderate; Heat-lightning S. W. |
| 196 | July | 13 | Active. |
| 197 | July | 16 | Moderate. |
| 198 | July | 17 | Faint. |
| 199 | July | 18 | In the zenith. |
| 200 | July | 22 | Vivid; high strcamers. |
| .... | July | 23 | A. |
| 201 | August | 4 | High; extended; bright arches and isolated clouds, the latter emitting streamers. At 10 P. M. a breeze sprung up from the E. N. E., forcing the streaming clouds towards the west, but leaving the arches undisturbed. The higher arches passed through *Cassiopœa*. Before the wind arose, streamers were seen south of the zenith. |
| 202 | August | 10 | Rather dim. |
| 203 | August | 11 | Faint; soon disappears. |
| 204 | August | 12 | High streamers. |
| 205 | August | 14 | Moderate. |
| 206 | August | 18 | High, extensive and active streamers. |
| 207 | August | 20 | Low; soon disappears. |
| .... | August | 21 | A. |
| 208 | August | 25 | After 12 ; moderate. |
| 209 | August | 26 | After 12h. |
| 210 | September | 8 | High; streamers; heat-lightning in N. E. |
| 211 | September | 10 | Moderate. |
| 212 | September | 11 | Rather faint. |
| 213 | September | 12 | Moderate; heat-lightning in N. E. |
| 214 | September | 20 | High; streamers; heat-lightning (once) in N. E. |
| .... | September | 28 | A. |
| 215 | October | 9 | High, but faint. |
| 216 | October | 10 | Dim. |
| 217 | October | 15 | Faint; all night. |
| 218 | October | 18 | High, strong beams. |
| 219 | October | 20 | Moderate. |
| 220 | November | 8 | Low; active streamers. |
| 221 | November | 11 | Low and dim. |
| | 1866. | | |
| 222 | January | 8 | Dim. |
| 223 | January | 20 | Moderate. |
| 224 | February | 1 | Rather faint. |
| 225 | February | 5 | Moderate. |

## LIST OF AURORAS, 1859–1884.

| No. | Year — Month. | Day. | Remarks. |
|---|---|---|---|
| 226 | March | 5 | Dim. |
| 227 | March | 7 | Moderate. |
| 228 | March | 9 | Low; h gh streamers. |
| 229 | March | 16 | Low; and faint. |
| 230 | March | 18 | Low; streamers. |
| 231 | May | 12 | Average brilliancy. |
| 232 | May | 14 | In the zenith. |
| .... | July | 7 | A. |
| 233 | July | 12 | Low; streamers. |
| 234 | July | 31 | Average brilliancy. |
| 235 | August | 9 | Moderate. Thunder storm above horizon from W. to E. |
| 236 | August | 15 | Moderate. |
| .... | September | 11 | A. |
| 237 | September | 12 | Moderate. |
| 238 | October | 5 | Low and dim. |
| .... | October | 7 | A. |
| 239 | October | 13 | Moderate; streamers. |
| .... | October | 24 | A. |
| | 1867. | | |
| 240 | March | 5 | Rather dim. |
| 241 | March | 7 | Average brilliancy. |
| 242 | May | 2 | Low. |
| 243 | May | 4 | Moderate. |
| 244 | May | 29 | High; streamers. |
| 245 | June | 22 | Moderate; heat lightning in S. |
| 246 | July | 18 | Moderate; unusual position in the west. |
| .... | July | 19 | A. |
| 247 | July | 21 | Moderate. |
| 248 | July | 22 | Dim. |
| 249 | July | 28 | Moderate. |
| 250 | July | 29 | Same. |
| .... | August | 5 | A. |
| .... | August | 10 | A. |
| 251 | August | 13 | Moderate. |
| 252 | August | 14 | Same. |
| 253 | August | 19 | Low and dim. |
| 254 | August | 23 | Moderate. Heat lightning in S. S. E. |
| 255 | September | 1 | Moderate. |
| 256 | September | 6 | Faint. |
| 257 | September | 9 | Rather faint. |
| 258 | September | 13 | Strong; streamers. |
| 259 | September | 16 | Moderate; heat lightning below N.W. horizon. |
| 260 | September | 20 | High; streamers. |
| 261 | September | 21 | Moderate. |
| 262 | September | 22 | Low; high streamers. |
| 263 | September | 25 | Very active; streamers. |
| 264 | September | 26 | High; high streamers. |
| 265 | September | 29 | Very extended; dim. |
| .... | October | 1 | A. |
| .... | October | 2 | A. |

LIST OF AURORAS, 1859-1884.

| No. | Year — Month. | Day. | Remarks. |
|---|---|---|---|
| 266 | October | 3 | Intense streamers: Thunder storm in W. |
| 267 | October | 23 | Rather dim. |
| 268 | November | 25 | Faint. |
| | 1868. | | |
| 269 | January | 12 | Rather faint. |
| 270 | January | 18 | Low; and faint. |
| 271 | February | 20 | Same. |
| 272 | March | 20 | Some streamers. |
| 273 | April | 12 | Situated unusually far to the West. |
| .... | April | 15 | A. |
| .... | April | 18 | A. |
| 274 | April | 19 | Somewhat extended. |
| 275 | April | 20 | Low; high streamers. |
| 276 | April | 27 | Extended but faint. |
| 277 | May | 9 | Average brilliancy. |
| 278 | May | 10 | Same. |
| 279 | May | 18 | Same. |
| 280 | May | 20 | Same. |
| 281 | May | 25 | Same. Heat lightning in W. |
| 282 | May | 30 | Of short duration. |
| 283 | June | 5 | Moderate. Heat lightning in N. E. |
| 284 | June | 10 | Very extensive. Covers part of the southern sky. Streamers on both sides of the zenith. |
| 285 | June | 18 | High streamers. Heat lightning below horizon S. S. E. |
| 286 | June | 20 | In zenith. |
| 287 | June | 29 | Low: with high streamers. |
| 288 | July | 1 | In zenith. |
| 289 | July | 4 | Average brilliancy: Heat lightning in S. S. E. |
| 290 | July | 7 | In zenith. |
| 291 | July | 8 | The centre exactly in the zenith. |
| 292 | July | 10 | Very extended: active streamers. |
| 293 | July | 11 | Moderate: Heat lightning in S. S. W. |
| 294 | July | 13 | Streamers: Heat lightning above N. E. horizon. |
| 295 | July | 14 | Vivid and active streamers. A thunder storm in the afternoon. |
| 296 | July | 16 | Low: Heat lightning in W. |
| 297 | July | 17 | Streamers: Same. |
| 298 | July | 18 | Average brilliancy: Heat lightning in S. E. |
| 299 | August | 9 | Low; 4°–5° above horizon. Streamers pass beyond zenith. |
| 300 | August | 11 | Low; high streamers |
| 301 | August | 13 | Low. |
| 302 | August | 18 | Low; streamers. |
| 303 | August | 20 | Low. |
| 304 | August | 31 | Very extended; active streamers. |
| 305 | September | 3 | Low and faint. |
| 306 | September | 6 | Average brilliancy. |

## LIST OF AURORAS, 1859–1884.

| No. | Year — Month. | Day. | Remarks. |
|---|---|---|---|
| 307 | September ..... ... | 12 | Unusually far east. |
| 308 | September ..... | 15 | Widely extended; consisting of detached clouds from which streamers rise. |
| 309 | September ..... .... | 18 | Active streamers. |
| 310 | September .... ..... | 20 | Average brilliancy. |
| 311 | September ..... | 22 | Same. |
| 312 | September ..... | 23 | Same. |
| 313 | September ..... ... | 30 | Dim. |
| 314 | October ..... | 14 | Low. |
| 315 | October ..... | 16 | Bright; no streamers. |
| 316 | October ..... | 22 | Average; with streamers. |
| 317 | November..... | 12 | Low and faint. |
| .... | November..... | 22 | A. |
| 318 | December ..... | 10 | Average brilliancy. |
| 319 | December ..... | 17 | Same. |
| | 1869. | | |
| 320 | January ..... | 6 | Same. |
| 321 | January ..... | 7 | Rather faint. |
| 322 | January ..... | 23 | Same. |
| 323 | February..... | 3 | Very high; active streamers. |
| 324 | February..... | 11 | Dim. |
| 325 | March ..... | 2 | Rather faint. |
| 326 | March ..... | 10 | Low; streamers. |
| 327 | March ..... | 17 | High; same. |
| 328 | March ..... | 23 | Low and faint. |
| 329 | April ..... | 2 | Very extended; streamers. |
| 330 | April . ..... | 3 | Low and streamers. |
| 331 | April ..... | 4 | Same. |
| 332 | April ..... | 5 | Extended; active streamers. |
| 333 | April ..... | 7 | Low. |
| 334 | April ..... | 9 | Low and faint. |
| 335 | April ..... | 10 | Same. |
| .... | April ..... | 12 | A. |
| 336 | April ..... | 16 | Very extended streamers beyond the zenith. |
| 337 | April ..... | 30 | In the zenith. |
| 338 | May ..... | 5 | Same. |
| 339 | May ..... | 7 | High streamers. |
| 340 | May ..... | 8 | Average brilliancy. |
| 341 | May ..... | 9 | Same; heat-lightning in W. |
| 342 | May ..... | 10 | In the zenith. |
| 343 | June..... | 1 | Average brilliancy. |
| 344 | June..... | 3 | Same. |
| 345 | June ..... | 4 | Same. |
| 346 | June ..... | 7 | Same. |
| 347 | September ..... | 27 | Very vivid; high streamers. |
| 348 | September ..... | 28 | Average brilliancy. |
| 349 | September ..... | 29 | Same. |
| 350 | October ..... | 25 | Same. |
| 351 | October ..... | 31 | High streamers. |
| 352 | December ..... | 4 | High arch; moderate streamers. |

## LIST OF AURORAS, 1859–1884.

| No. | Year — Month. | Day. | Remarks. |
|---|---|---|---|
| | 1870. | | |
| 353 | January | 3 | Average brilliancy. |
| 354 | January | 4 | Same; rather far E. |
| 355 | January | 26 | Low and faint. |
| 356 | January | 31 | Same. |
| 357 | February | 3 | Faint. |
| 358 | February | 11 | Average brilliancy. |
| 359 | February | 20 | Low; active streamers. |
| 360 | February | 24 | Average brilliancy. |
| 361 | March | 1 | Same; streamers. |
| 362 | March | 2 | Faint. |
| 363 | March | 3 | Moderate streamers. |
| 364 | March | 13 | Rather faint. |
| .... | March | 21 | A. |
| 365 | March | 28 | Rather faint. |
| 366 | April | 2 | Same. |
| 367 | April | 5 | High streamers. |
| 368 | April | 20 | Average brilliancy. |
| 369 | April | 21 | Same. |
| 370 | April | 25 | Same. |
| 371 | May | 1 | Same. |
| 372 | May | 19 | Extends over whole northern sky; streamers in isolated groups. |
| 373 | June | 15 | Very active streamers. |
| 374 | June | 17 | Low; high streamers. |
| 375 | June | 19 | Same. |
| 376 | June | 20 | Moderate streamers. |
| 377 | June | 21 | Faint. |
| 378 | June | 26 | Average brilliancy. |
| 379 | July | 27 | High; active streamers. Heat lightning in E. to S. |
| 380 | August | 19 | Extended; active streamers. |
| 381 | August | 21 | Rather faint. |
| 382 | August | 25 | Average brilliancy. |
| .... | August | 26 | A. |
| .... | August | 29 | A. |
| 383 | September | 3 | Extended but faint. |
| 384 | September | 17 | Low; active streamers. |
| 385 | September | 18 | Average brilliancy. |
| 386 | September | 20 | Same. |
| 387 | September | 21 | Same; in easterly position. |
| 388 | September | 25 | Average brilliancy. |
| 389 | September | 26 | In zenith. |
| 390 | October | 14 | Very high; thunderstorm in N. |
| 391 | October | 20 | Average brilliancy. |
| 392 | October | 27 | Same; but extending to both sides of the zenith. |
| 393 | November | 12 | $8^h\,15^m$. A dark grey haze covering the zenith. After half an hour the nebulous body moves north, forming an arch emitting streamers. |
| 394 | November | 14 | In the zenith. Streamers plainly seen. |
| 395 | November | 17 | Dim. |
| 396 | November | 21 | Dim. |

LIST OF AURORAS, 1859–1884.

| No. | Year—Month. | Day. | Remarks. |
|---|---|---|---|
| 397 | November | 24 | High; streamers. |
| 398 | December | 3 | Faint. |
| 399 | December | 15 | Much extended; high streamers. |
| 400 | December | 21 | Average brilliancy. |
| 401 | December | 22 | Low and faint. |
| 402 | December | 24 | Same. |
| .... | December | 26 | A. |
| | 1871. | | |
| 403 | January | 20 | Extended over whole north sky. |
| 404 | January | 21 | Rather faint. |
| .... | January | 24 | A. |
| 405 | February | 10 | Average streamers. |
| 406 | February | 13 | Same. |
| 407 | February | 21 | Same. |
| 408 | February | 24 | Very vivid; active streamers. |
| 409 | March | 21 | Average brilliancy. |
| 410 | March | 28 | Same. |
| 411 | April | 1 | Same. |
| 412 | April | 9 | Active streamers. |
| 413 | April | 11 | High streamers. |
| 414 | April | 13 | Same. |
| 415 | May | 7 | Dim. |
| 416 | May | 8 | Average brilliancy. |
| 417 | May | 19 | High streamers. Heat lightning in N. E. |
| .... | May | 18 | A. |
| 418 | May | 21 | Moderate streamers. |
| 419 | May | 22 | High streamers. |
| 420 | June | 6 | Same. |
| 421 | June | 10 | Very extended and active streamers. |
| 422 | June | 15 | Dim. |
| 423 | June | 17 | Extended; moderate streamers. |
| 424 | July | 2 | Vivid; high streamers. |
| 425 | July | 14 | Average brilliancy. |
| 426 | July | 21 | Same. |
| 427 | July | 23 | Same. |
| 428 | August | 5 | Same. Heat lightning in north. |
| 429 | August | 11 | Moderate. |
| 430 | August | 12 | Faint. |
| 431 | August | 17 | Moderate. |
| 432 | August | 23 | Same. |
| 433 | September | 6 | Low and faint. |
| 434 | September | 7 | Very extended; moderate streamers. |
| 435 | October | 10 | Average brilliancy. |
| 436 | November | 1 | Faint. |
| 437 | November | 10 | Same. |
| 438 | November | 14 | Same. |
| 439 | December | 8 | Extended; active streamers. |
| .... | December | 9 | A. |
| 440 | December | 10 | In zenith; streamers. |
| .... | December | 16 | A. |

LIST OF AURORAS, 1859–1884.

| No. | Year — Month. | Day. | Remarks, |
|---|---|---|---|
| | 1872. | | |
| 441 | February | 4 | Average brilliancy. |
| 442 | February | 5 | Same. |
| .... | March | 5 | A. |
| 443 | March | 20 | Active streamers. |
| 444 | March | 28 | Average brilliancy. |
| 445 | April | 3 | Same. |
| 446 | April | 10 | Near the zenith; streamers shooting up from detached clouds. |
| .... | April | 27 | A. |
| 447 | May | 24 | High streamers. |
| 448 | May | 30 | Rather faint. |
| 449 | June | 15 | Average brilliancy. |
| 450 | June | 22 | Rather faint. |
| 451 | July | 27 | Average brilliancy. |
| 452 | August | 3 | Very high; extending over part of the S. sky. |
| 453 | August | 8 | Moderate: thunder storm in the N.W. horizon. |
| 454 | August | 14 | At 9 P. M. the northern sky presented a very shining aspect, with nothing visible which could explain the source of the illumination. |
| 455 | August | 20 | Aurora in zenith; heat lightning in N. |
| 456 | August | 24 | High; streamers. |
| 457 | August | 25 | Same; heat lightning in S. E. |
| 458 | August | 26 | Same; same in E. S. E. |
| 459 | August | 29 | Low with high streamers. |
| 460 | September | 4 | High; with streamers. |
| 461 | September | 5 | Same; heat lightning in S. E. |
| 462 | September | 29 | Average brilliancy. |
| 463 | October | 14 | In the zenith. |
| 464 | October | 16 | Average brilliancy. |
| 465 | October | 28 | Low; with streamers which originate below (or at) the horizon and extend high. |
| 466 | November | 23 | Low and faint. |
| 467 | November | 27 | Average brilliancy. |
| | 1873. | | |
| .... | January | 5 | A. |
| 468 | January | 18 | High; active streamers. |
| 469 | January | 25 | Average brilliancy. |
| 470 | February | 1 | Same. |
| 471 | February | 4 | Faint. |
| 472 | February | 21 | Low and faint. |
| 473 | February | 23 | Low; high streamers. |
| 474 | February | 24 | Average brilliancy. |
| 475 | March | 3 | Dim. |
| 476 | March | 21 | Moderately extended; streamers. |
| 477 | March | 23 | Average brilliancy. |
| 478 | March | 29 | Rather faint. |
| 479 | April | 18 | Faint. |

LIST OF AURORAS, 1859–1884.

| No. | Year — Month. | Day. | Remarks. |
|---|---|---|---|
| 480 | April | 21 | Faint. |
| 481 | May | 15 | Average brilliancy. |
| 482 | May | 16 | Dim. |
| 483 | May | 23 | Average brilliancy. |
| 484 | May | 28 | Same. |
| 485 | June | 1 | Intense; with streamers. |
| 486 | June | 11 | Dim. |
| 487 | June | 18 | Extended but faint. |
| 488 | June | 20 | Faint. |
| 489 | June | 23 | Average brilliancy. Heat lightning in W. and N. |
| 490 | June | 24 | Average brilliancy. |
| 491 | June | 26 | Extended; active streamers. |
| 492 | June | 27 | High; same. |
| 493 | July | 16 | Rather faint. |
| 494 | July | 21 | Low; active streamers. |
| 495 | July | 30 | Faint. |
| 496 | August | 12 | Average brilliancy. |
| 497 | August | 17 | Same; thunderstorm low in S. |
| 498 | August | 18 | Low. |
| 499 | August | 26 | Average brillancy; after $12^h$. |
| 500 | August | 27 | Low; high streamers. |
| 501 | September | 13 | Average brilliancy. |
| 502 | September | 22 | Rather dim. |
| 503 | December | 14 | Average brilliancy. |
| | 1874. | | |
| 504 | February | 14 | Same. |
| 505 | March | 7 | Extended but rather faint. |
| 506 | March | 8 | Average brilliancy. |
| 507 | April | 3 | Low. |
| 508 | April | 6 | Average brilliancy. |
| 509 | April | 7 | High; with streamers. |
| 510 | May | 4 | Vivid; same. |
| 511 | June | 3 | High; with streamers. |
| 512 | July | 12 | Low; moderate streamers. |
| 513 | August | 12 | High; streamers. |
| 514 | September | 11 | Faint; heat lightning in W. N. W. |
| 515 | October | 3 | Extended; high streamers. |
| 516 | October | 4 | Average brilliancy. |
| 517 | October | 6 | Average brilliancy. |
| 518 | October | 13 | Average brilliancy. |
| 519 | November | 7 | Average brilliancy. |
| 520 | November | 28 | High; streamers. |
| 521 | November | 29 | Low and faint. |
| | 1875. | | |
| 522 | February | 24 | Dim. |
| 523 | February | 26 | Extended and active streamers. |
| 524 | March | 2 | Average brilliancy. |
| 525 | April | 7 | Same. |
| .... | May | 2 | A. |
| 526 | July | 26 | Rather faint. |
| 527 | July | 30 | Same. |

## LIST OF AURORAS, 1859–1884.

| No. | Year — Month. | Day. | Remarks. |
|---|---|---|---|
| .... | September | 3 | A. |
| 528 | September | 7 | Over the whole N. sky. |
| .... | September | 8 | A. |
| 529 | October | 31 | Average brilliancy. |
| | 1876. | | |
| 530 | January | 14 | Low. |
| 531 | January | 27 | Low. |
| 532 | February | 13 | Average brilliancy. |
| 533 | February | 17 | Extended but faint. |
| 534 | February | 19 | Same; active streamers. |
| 535 | March | 25 | Faint. |
| 536 | March | 26 | Same. |
| 537 | July | 16 | Average brilliancy; streamers. |
| 538 | August | 11 | Low; high streamers. |
| 539 | August | 12 | Average brilliancy. |
| 540 | September | 22 | Very bright; no streamers seen. |
| 541 | November | 10 | Dim. |
| 542 | November | 14 | Dim. |
| 543 | December | 7 | Dim. |
| | 1877. | | |
| 544 | January | 7 | Low and dim. |
| 545 | March | 9 | Extended; active streamers. |
| 546 | April | 5 | Faint. |
| 547 | April | 14 | High; streamers. |
| 548 | May | 2 | Same. |
| 549 | May | 28 | Same. |
| .... | June | 19 | A. |
| 550 | October | 11 | Extended but faint. |
| 551 | November | 9 | Average brilliancy. |
| .. | December | 6 | A. |
| | 1878. | | No aurora was seen by the observer during 1878 within usual hours of observation. |
| | 1879. | | |
| 552 | April | 19 | High; streamers. |
| 553 | June | 17 | Same. |
| 554 | September | 10 | Low and faint. |
| 555 | October | 8 | Same. |
| | 1880. | | |
| 556 | February | 15 | Dim. |
| 557 | March | 12 | High; streamers. |
| 558 | April | 1 | Moderate streamers. |
| .... | April | 9 | A. |
| 559 | May | 1 | Average brilliancy. |
| 560 | May | 14 | Same. |
| 561 | August | 5 | Rather faint. |
| 562 | August | 12 | High; streamers. |

LIST OF AURORAS, 1859–1884.

| No. | Year — Month. | Day. | Remarks. |
|---|---|---|---|
| 563 | August | 13 | High streamers; heat-lightning in N.E. |
| 564 | August | 27 | Same. Thunder storm on the previous afternoon. |
| 565 | August | 31 | Average brilliancy; heat lightning in E. and S. E. |
| 566 | September | 27 | High; streamers. |
| 567 | October | 7 | Average brilliancy. |
| | 1881. | | |
| 568 | March | 18 | Same; streamers. |
| 569 | April | 28 | High; streamers; thunder storm in day. |
| 570 | September | 12 | Average brilliancy. |
| .... | September | 13 | A. |
| 571 | November | 8 | Very active streamers still visible in morning of November 9th. |
| 572 | November | 19 | Average brilliancy. |
| 573 | November | 23 | Extended but faint. |
| 574 | December | 8 | Average brilliancy. |
| 575 | December | 9 | Rather dim. |
| 576 | December | 14 | Extended; high streamers, |
| 577 | December | 23 | Average brilliancy. |
| | 1882. | | |
| 578 | January | 11 | Low: high streamers. |
| 579 | January | 19 | Extended; moderate streamers. |
| .... | February | 1 | A. |
| 580 | February | 5 | Low; few streamers. |
| 581 | February | 9 | Same. |
| 582 | February | 12 | Same. |
| 583 | February | 13 | Aurora in the zenith, concealed by a dark haze. In N. E. and S. W. where the clouds are divided, streamers are seen. |
| 584 | April | 15 | Rather faint. |
| 585 | April | 16 | Extended; active streamers. |
| 586 | April | 20 | Average brilliancy. |
| 587 | August | 10 | Moderate streamers. |
| 588 | September | 3 | Low, and at long intervals a few streamers. |
| 589 | October | 14 | Low; streamers. |
| 590 | October | 16 | Low and faint. |
| 591 | November | 13 | Low; a few streamers. |
| .... | November | 15 | A. |
| 592 | November | 18 | Extended; moderate streamers. |
| 593 | November | 19 | Moderate streamers, |
| 594 | December | 15 | Extended; same. |
| | 1883. | | |
| 595 | February | 27 | Moderate streamers. |
| .... | February | 28 | A. |
| .... | March | 2 | A. |

LIST OF AURORAS, 1859–1884.

| No. | Year — Month. | Day. | Remarks. |
|---|---|---|---|
| 596 | March | 28 | Average brilliancy. |
| 597 | April | 15 | Same. |
| 598 | April | 24 | Same. |
| 599 | July | 29 | Rather faint. |
| .... | July | 30 | A. |
| 600 | July | 31 | Dim, |
| 601 | August | 4 | In the zenith; occasionally streamers are seen. |
| 602 | August | 7 | Rather faint. |
| 603 | September | 4 | Faint. |
| 604 | September | 16 | Very extended; active streamers. |
| 605 | September | 25 | Low; high streamers. |
| 606 | November | 1 | Average brilliancy. |
| 607 | November | 2 | Same. |
| 608 | December | 1 | Same." |

The following summary of Mr. LUEDER's observations may be found useful. It refers *only* to this series, and does not include the auroras observed at Madison.

NUMBER OF AURORAS IN THE YEARS 1859—1884.

| Year. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Sums. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1859 | ..... | ..... | ..... | ..... | ..... | ..... | 3 | 1 | 6 | 3 | 1 | 1 | 15 |
| 1860 | 3 | 1 | 4 | 3 | 5 | 0 | 3 | 16 | 15 | 4 | 0 | 2 | 56 |
| 1861 | 1 | 2 | 2 | 1 | 1 | 0 | 0 | 7 | 7 | 3 | 0 | 3 | 27 |
| 1862 | 2 | 1 | 1 | 4 | 2 | 4 | 8 | 8 | 5 | 5 | 0 | 1 | 41 |
| 1863 | 3 | 1 | 1 | 5 | 0 | 1 | 4 | 2 | 3 | 4 | 3 | 1 | 28 |
| 1864 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 2 | 2 | 4 | 2 | 0 | 14 |
| 1865 | 2 | 3 | 2 | 1 | 4 | 2 | 5 | 9 | 5 | 5 | 2 | 0 | 40 |
| 1866 | 2 | 2 | 5 | 0 | 2 | 0 | 2 | 2 | 1 | 2 | 0 | 0 | 18 |
| 1867 | 0 | 0 | 2 | 0 | 3 | 1 | 5 | 4 | 11 | 2 | 1 | 0 | 29 |
| 1868 | 2 | 1 | 1 | 4 | 6 | 5 | 11 | 6 | 9 | 3 | 1 | 2 | 51 |
| 1869 | 3 | 2 | 4 | 9 | 5 | 4 | 0 | 0 | 3 | 2 | 0 | 1 | 33 |
| 1870 | 4 | 4 | 5 | 5 | 2 | 6 | 1 | 3 | 7 | 3 | 5 | 5 | 50 |
| 1871 | 2 | 4 | 2 | 4 | 5 | 4 | 4 | 5 | 2 | 1 | 3 | 2 | 38 |
| 1872 | 0 | 2 | 2 | 2 | 2 | 2 | 1 | 8 | 3 | 3 | 2 | 0 | 27 |
| 1873 | 2 | 5 | 4 | 2 | 4 | 8 | 3 | 5 | 2 | 0 | 0 | 1 | 36 |
| 1874 | 0 | 1 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 4 | 3 | 0 | 18 |
| 1875 | 0 | 2 | 1 | 1 | 0 | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 8 |
| 1876 | 2 | 3 | 2 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 2 | 1 | 14 |
| 1877 | 1 | 0 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 8 |
| 1878 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1879 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 4 |
| 1880 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | 5 | 1 | 1 | 0 | 0 | 12 |
| 1881 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 4 | 10 |
| 1882 | 2 | 4 | 0 | 3 | 0 | 0 | 0 | 1 | 1 | 2 | 3 | 1 | 17 |
| 1883 | 0 | 1 | 1 | 2 | 0 | 0 | 2 | 2 | 3 | 0 | 2 | 1 | 14 |
| Sums... | 31 | 43 | 44 | 54 | 47 | 39 | 56 | 89 | 91 | 54 | 34 | 26 | 608 |

## ERRATA AND ADDITIONS TO VOL. I.

Page 8. The longitude of the 6-inch Equatorial is $+0^h\ 49^m\ 25^s.60$.

84. No. 35. R. A. for $19^h\ 17^m\ 1^s$, read $19^h\ 16^m\ 52^s$. Dec. for $-18°\ 43'$, read $-18°\ 44'$. For 1781.638, read 1881.638.

86. No. 42. For Anon, read Aoe, 20926. Dec. For $-17°\ 44'$, read $-17°\ 46'$.

161. VIII. Title, *dele* the word "Reduce."

161. Line 9 from top: R. A. for $1^h\ 58^m\ 45^s$, read $1^h\ 48^m\ 45^s$.

168. The position of the Lick Observatory from Coast Survey data, kindly communicated by PROF. DAVIDSON, is,

Latitude $= +37°\ 20'\ 23''.5$.

Longitude $= 8^h\ 6^m\ 34^s.15$ (Greenwich.)

Longitude $= 2^h\ 58^m\ 22^s.06$ (Washington.)

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## ERRATA AND ADDITIONS TO VOL. II.

Page 2, line 10; for A read An.

35, line 20; for $\pm$ 0.005 read $\pm$ 0.0005.

35, line 25; for + 0.00045 read + 0.0045.

35, from measures of the distances of the wires of the glass reticle (May 1884) the value of the R. A. screw is $4^s.271 \pm 0.0015$. The adopted value of the screw, from both series is $4^s.283$.

41, diameter of pivots; for 1.333 read 1.339.

### NOTE TO PAGE 72.

During the period July 9–Aug. 22 the North Collimator micrometer was used to set on the fixed wires of the S. C. which remained untouched. The N. C. itself was unchanged, except as to its micrometer. The variations in the micrometer reading for the coincidence of the collimators show then the sum of the variations in the collimation of the N. C. and S. C. and of any variations in the relative positions of the Ys of the two collimators, due either to bodily movement of the brick piers or to shifts in the position of their adjusting screws. The table gives the reading for coincidence for each day. During the period July 9–13 to July 24–28 the total angular change was 4".97. Supposing the S. C. to remain absolutely fixed and the whole change to be in the brick pier of the N. C. it would follow that the change of this pier was less than 0.005 inches to the *East*. From July 24–28

to Aug. 6–9 the whole change was 3″.64. Under the same suppositions, the brick pier of the N. C. moved less than 0.004 inches to the *West.* From Aug. 5–9 to Aug. 19–22, the whole change was 1″.61. Under the same suppositions, the brick pier of the N. C. moved less than 0.002 inches to the *East.* It appears to me that these figures show a remarkable stability in the piers, in the collimator micrometers and in the mountings of the Ys of the collimators themselves. Even when the sum of all the possible changes is thrown upon the change of the brick pier of the N. C. alone, the mean daily movement of this pier (using all the observations) is not above 0.001 inches in the direstion East—West. The variations in level are much greater.

| Date. | Rev. | Date. | Rev. | Date. | Rev. | Date. | Rev. |
|---|---|---|---|---|---|---|---|
| 1883. | | 1883. | | 1883. | | 1883. | |
| July 9.. | .828 | July 24.. | .732 | Aug. 8... | .760 | Aug. 28... | ..... |
| 10.. | .816 | 25.. | .723 | 9... | .756 | Setting of S. C. changed. | ..... |
| 11.. | .798 | 26.. | .724 | 10... | .752 | Aug. 23... | .097 |
| 12.. | .758 | 27.. | .707 | 11... | .740 | 24... | .102 |
| 13.. | .765 | 28.. | .722 | 12... | .751 | 25... | .105 |
| 14.. | .776 | 29.. | .720 | 13... | .751 | 26... | .106 |
| 15.. | .755 | 30.. | .734 | 14... | .778 | 27... | .119 |
| 16.. | .742 | 31.. | .733 | 15... | .708 | 28... | .108 |
| 16.. | .735 | Aug. 1.. | .732 | 16... | .753 | 29... | .109 |
| 17.. | .740 | 2.. | .728 | 17... | .755 | 30... | .198 |
| 18.. | .795 | 3.. | .710 | 18... | .755 | 31... | .097 |
| 19.. | .800 | 3.. | .777 | 19... | .757 | Sept. 3... | .097 |
| 20.. | .801 | 4.. | .780 | 20... | .754 | ..... | ..... |
| 21.. | .746 | 5.. | .778 | 21... | .748 | ..... | ..... |
| 22.. | .727 | 6.. | .820 | 21... | .749 | ..... | ..... |
| 23.. | .730 | 7.. | .757 | 22... | .757 | ..... | ..... |

Page 76, line 22; for N. C. read U. C.
83, line 12; for C–D read D–C.
85, line 23; for single read nine.
98, No. 101, column Remarks, dele ?
99, No. 108, column Name; dele ?

Page 99, No. 108, column R. A.; for $16^s$ read $15^s$.
99, No. 108, column Dec; for 57′ read 58′.
110, No. 7, for 17728 read 17704.
110, No. 9, for $48^s.10$ read $48^s.5$,
111, No. 18, add Time $\pm 0^s.3$.
111, No. 22, for $52^s.49$ read $52^s.62$,
116, No. 37, for —12° 23′ read +12° 23′.
121, No. 175, for 13.3 read 31.3.
124, No. 250, for 5.6 read 5 — 6.
124, No. 270, for Struve's read strong.
127, No. 342, for — 8 15 read — 8 51.
128, No. 377, for gazing read gaging.
134, No. 515, for 48 35 read 43 35.
135, No. 542, for +28 44 read +29 24.
135, No. 553, for +11 34 read +17 34.
136, No. 593, for 47.0 read 17.4.

| Page. | Line. | Col. | For | Read |
|---|---|---|---|---|
| 144 | 5 | Sweep. | 353 | 358 |
| 144 | 8 | Remarks. | Same. | Some. |
| 145 | 6 | Sweep. | 332 | 362 |
| 145 | 11 | R. A. | 26 | 36 |
| 145 | 14 | R. A. | 33 | 53 |
| 145 | 14 | N. P. D. | 27 | 37 |
| 145 | 15 | N. P. D. | 37° 21′ | 101° 37′ |
| 145 | 15 | No. Stars. | 21 | 21.1 |
| 145 | 27 | R. A. | 3 | 8 |
| 146 | 11 | R. A. | 13 | 18 |
| 147 | 3 | N. P. D. | 103 | 108 |
| 148 | 19 | N. P. D. | 19 | 49 |
| 148 | 21 | N. P. D. | 36 | 56 |
| 150 | 9 | R. A. | 29 | 39 |
| 150 | 13 | N. P. D. | 50 | 56 |
| 150 | 14 | N. P. D. | 38 | 39 |
| 150 | 17 | R. A. | 10 | 16 |
| 152 | 27 | R. A. | 32 | 28 |
| 153 | 20 | R. A. | 28 | 23 |
| 153 | 29 | N. P. D. | 37 | 39 |
| 154 | 29 | No. Gauges. | ½ | ⅛ |
| 155 | 8 | R. A. | 25 | 28 |
| 156 | 11 | Sweep. | 716 | 715 |
| 156 | 17 | No. Stars. | 2.3 | 20.3 |
| 156 | 21 | Sweep. | 815 | 816 |

Page 164, No. 827; for $7^h\ 52^m\ 1^s$, read $7^h\ 2^m\ 1^s$.
188, No. 296; for 60 read 69.
261, Table; for $23^h\ 40^m$ read $23^h\ 20^m$.
262, Table; for $15^h\ 30^m$ read $15^h\ 20^m$.
263, Table; for $8^h\ 30^m$ read $8^h\ 20^m$.
263, Table; under $13^h\ 0^s$ ; $+3°$, read 3.054.
264, Table; interchange $21^h\ 20^m$ and $21^h\ 30^m$.
269, Table; line 2, supply "R." and "for."

# APPENDIX

## Catalogue of the Woodman Astronomical Library

OF THE

## WASHBURN OBSERVATORY

UNIVERSITY OF WISCONSIN.

PART I.—TO JUNE 1, 1884.

## TRUSTEES OF THE WOODMAN ASTRONOMICAL LIBRARY FUND.

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HON. ORSAMUS COLE,

CHIEF JUSTICE OF THE SUPREME COURT OF WISCONSIN.

HON. WILLIAM F. VILAS,

REGENT OF THE UNIVERSITY OF WISCONSIN.

PROF. EDWARD S. HOLDEN,

DIRECTOR OF THE WASHBURN OBSERVATORY.

## INTRODUCTORY NOTE.

The books in the library come from the following sources:

(*a*) From the professional library of Professor JAMES C. WATSON; these were bequeathed by him to the National Academy of Sciences, and are loaned by the Academy to the Washburn Observatory;

(*b*) From books purchased from funds given by Governor C. C. WASHBURN; this category comprises nearly all books bought before 1883;

(*c*) From books purchased during 1883 from a specific gift of Hon. CYRUS WOODMAN;

(*d*) From books bought from a permanent fund provided for the support of the library by Mr. WOODMAN;

(*e*) From gifts to the Washburn Observatory from scientific societies, from observatories, and from astronomers at home and abroad.

The following pages contain a catalogue of the books and pamphlets in the library at the date of printing. The catalogue is arranged alphabetically by authors, except that for convenience, the title word for observatories, scientific societies and government departments, is taken as the city in which the observatory, society, etc., has its permanent home. Complete volumes issued by an observatory, are usually credited to the observatory and not to the author.

Extracts from observatory publications are, however, credited to the author, and so in similar cases. In so small a library as this, no attempt at bibliographic accuracy is required. The *format* of books as 4to, 8vo, etc., as here given relates rather to their size. For exact information the catalogue of the great astronomical library at Pulkova should be consulted; when such work is once done in a perfect manner, it need not be continually repeated.

One word may be said of the arrangement of the books and pamphlets in the library. While the catalogue is arranged by authors only, the books are arranged on the

shelves by subjects. The pamphlets are kept in large drawers immediately below the book shelves, and a drawer is devoted to a subject. As soon as a pamphlet is received it is catalogued under its author's name, and placed in the drawer devoted to its subject. All the pamphlets on a given subject can therefore be at once consulted in one place; and all the works of a given author are to be found together in the card catalogue. I have used this plan for keeping pamphlets for eleven years, in my own library, in the library of the United States Naval Observatory, and here, and I consider it to be an entirely satisfactory solution of the troublesome problem of how to treat pamphlets in professional libraries. I give below a list of the subjects which have been adopted. These titles are printed in large letters on the front of each drawer.

Mathematics, Mathematical Tables; Catalogues of Stars, Ephemerides; Astronomical Tables; Geodesy in General; Geography; Terrestrial Physics; Geographical Positions; The Sun, Solar Eclipses, Solar Parallax; The Moon, Occultations; Theoretical Astronomy, Methods; Planets, Transits of Inferior Planets; Fixed Stars, in General; New and Variable Stars, Double and Binary Stars; Astronomical Constants, Precession, Aberration, Nutation, Obliquity, Refraction, etc.; Proper Motions of Stars, Stellar Parallax; Nebulae and Clusters; Observatories, Reports of (Descriptions); Astronomical Instruments, Price Lists, (Descriptions); Comets, Meteors, Zodiacal Light; Optics, Photometry; Meteorology, in General; Astronomical Biography; Astronomical Bibliography; Publisher's Book Lists; Time-Services, etc.; Star-Charts and Atlases.

I shall be glad if those to whom this volume is sent will turn to the pages in the following catalogue which give the works written by them, and see if it is in their power to supply the missing volumes of our collection. Any such contributions will be very gratefully received. They may be sent through the Smithsonian Institution, Washington, free of expense, and should be addressed to the Library of the Washburn Observatory, Madison, Wisconsin.

EDWARD S. HOLDEN.

# CATALOGUE OF THE LIBRARY.

ABBE (C.): The Portable Transit instrument in the vertical of the Pole Star (translated from W. DOELLEN). Washington, 1870. 8vo.

———: Historical Note on Least Squares. New Haven, 1871. 8vo.

———: Auroras 1776–1784, in Labrador. New Haven, 1873. 8vo.

———: Report on the Solar Eclipse of July, 1878. Washington, 1881. 4to.

ADAMS (J. C.): Note on the value of EULER'S Constant, etc. London, 1877. 8vo.

———: On the expression of the product of any two LEGENDRE'S coefficients by a series of LEGENDRE'S coefficients. London, 1877, 8vo.

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———: Catalogue of 1,439 stars for 1840.0.

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———: Description of the Great Equatorial at the Royal Observatory, Greenwich. London (1868). 4to.

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———: *See* Encyclopædia of Astronomy.

ALBANY: Dudley Observatory. Dudley Observatory and the Scientific Council. Albany, 1858. 8vo.

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———: Harmonies of the Solar System. Washington, 1875. 4to.

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AUWERS (A.): Neue Reduction der BRADLEY'SCHEN Beobachtungen, 1750–1762. Zweiter Band. St. Petersburg, 1882. 4to.

BACHE (A. D.): Magnetic Survey of Pennsylvania. Washington. 4to.

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BALL (R. S.): Elements of Astronomy. London, 1880. 8vo.

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